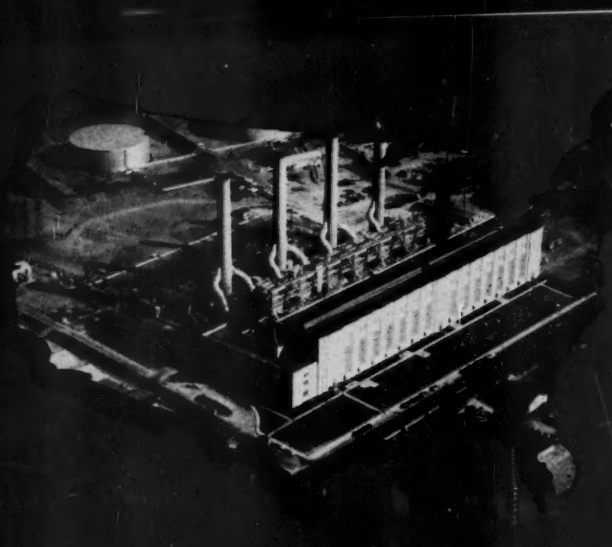
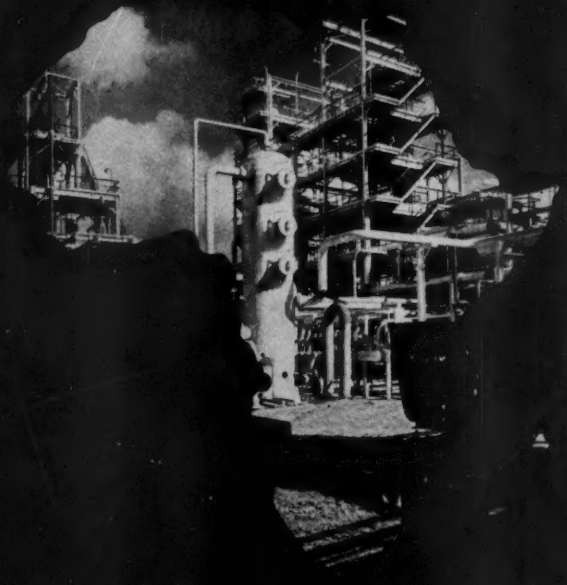


may 1951

# IV

# tech engineering news



*Another page for* **YOUR BEARING NOTEBOOK**

## How to keep a roll neck from becoming a bottleneck

Bearings in a billet mill have to be rugged to carry the tremendous separating forces in the rolling of steel. To insure continuous production and long, trouble-free performance, engineers specify Timken® roll neck bearings. That's because Timken balanced proportion roll neck bearings permit higher rolling speeds, minimize roll neck wear, and have maximum capacity.

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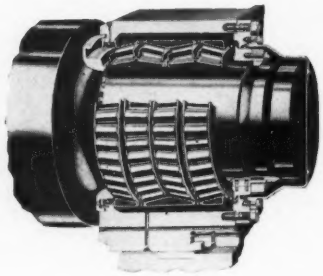

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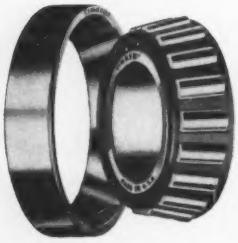

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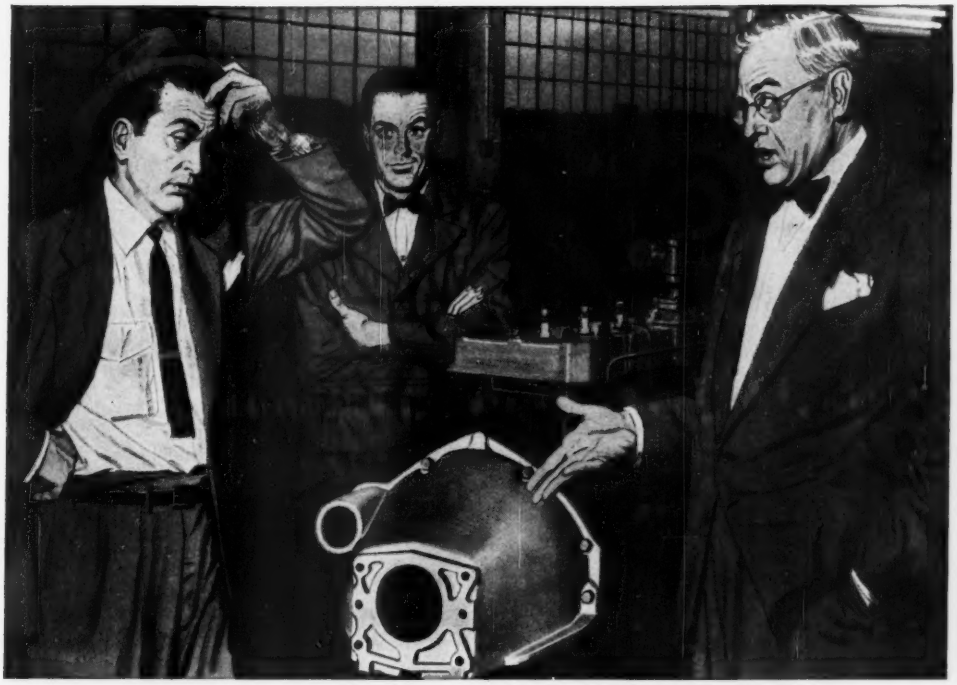
*TAPERED ROLLER BEARINGS*

## Learn more about bearings

Some of the engineering problems you'll face after graduation will involve bearing problems. If you'd like to learn more about this phase of engineering, we'll be glad to help. For additional information about Timken bearings and how engineers use them, write today to The Timken Roller Bearing Company, Canton 6, Ohio. And don't forget to clip this page for future reference.

**NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL ⬮ AND THRUST ⬮ LOADS OR ANY COMBINATION ✳**



# Why can't this be an ALUMINUM DIE CASTING?

This challenge was thrown at us by a leading automobile maker.

"It's possible," we agreed. But . . . the clutch housing also supports half the engine's weight, it is highly stressed, must absorb vibration. Could a die casting economically be made that strong?

An Alcoa Development Program was started. With the auto maker we drew up designs. We selected our strongest die casting alloy; poured *sand castings* from it; machined it to the dimensions of the die casting design.

Shear static loads and bending stresses were measured. Brittle lacquer and strain gauges show us stress concentrations. Castings, engine and transmission were assembled, then run with an unbalanced shaft to measure dynamic stresses.

With the auto maker we modified designs. Die castings were made. We repeated the laboratory tests while the auto maker made road tests. The first stressed automotive die casting was a success. 25% stronger in shear, 10% stronger in bending, 100% better in fatigue life than the original clutch housing. Only ¼ as much weight as the original cast-iron housing. *And 15% lower in cost.*

This case is typical of the engineering problems Alcoa men undertake and solve. Throughout the Alcoa organization similar challenging jobs are in progress now and others are waiting for the men with the imagineering ability to tackle them.

ALUMINUM COMPANY OF AMERICA, 1825 Gulf Building, Pittsburgh 19, Pennsylvania.

*A business built on co-operation*

ALCOA®

ALCOA

ALUMINUM COMPANY OF AMERICA

# Oh say can you see-

"That's Jonesey—putting out his flag again.

"He hasn't missed one Sunday in the eight years we've been neighbors. I used to kid him about it a lot. Asked him why didn't he buy a cannon to shoot off with it. He took it good-natured-like. But we got to talking last week about war in general. That was the first time I even knew he had a son.

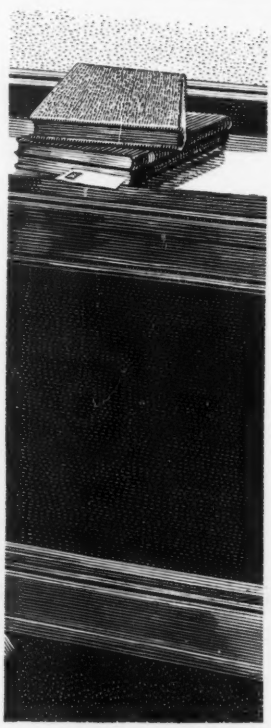
"His boy, Joe, enlisted right after Pearl Harbor and got overseas fast. When young Joe came back, Jonesey met him at the railroad station, stayed up with him all night and rode out with him to the cemetery on the hill. After it was all over, the sergeant gave Jonesey the flag that had covered Joe. *That's it over there.* I don't kid Jonesey any more.

"Instead, I've been listening respectfully when he talks about the flag . . . only when *he* says it, it's Flag. With a capital F. Same capital F he puts on Freedom, which is what he really means. Jonesey sure made me think about Freedom a lot. For instance . . .

"When I vote, nobody knows where I put my X's. Nobody puts me in jail for picking out my own church. And no teachers tell my kids to spy on me and turn me in because I squawk about taxes or high prices. And when I told my boss I was quitting to open a little grocery with the dough I'd saved in war bonds, he wished me luck and said he'd have his missus buy their groceries from me.

*"That's* what Jonesey meant when he said our Freedom is right under our noses. Can't feel it or see it. But it's there just the same, wrapped up in every star and stripe in that Flag across the street.

"And, if you'll excuse me, I'm going outside and hoist *my own* Flag, too . . . just bought it last night. 'Oh say can you see?' *I sure can . . . now!"*



## REPUBLIC STEEL

**Republic Building, Cleveland 1, Ohio**

***Republic BECAME strong in a strong and free America. Republic can REMAIN strong only in an America that remains strong and free*** . . . an America who owes much of her prosperity to her many huge industries that provide her people with the world's finest living. *Through these many industries, Republic serves all America.* A typical example can be found in the Petroleum Industry whose products furnish much of the nation's power, heat and light. In this production, too, steel plays a vital role . . . carbon, alloy and stainless . . . much of which comes from the many mills of Republic.

* * *

*For a full color reprint of this advertisement, write Republic Steel, Cleveland 1, Ohio*

# THE DU PONT DIGEST

## Research Takes the Long View

**Fundamental studies are one of the most important phases of Du Pont research**

Fundamental research is designed to discover new scientific facts without regard to specific commercial use. Yet from it have come many products of commercial significance.

At Du Pont, for instance, fundamental research has pointed the way to products like nylon, the first wholly synthetic organic textile fiber, and neoprene chemical rubber, to name only two.

**Where long-range** *and fundamental research is emphasized: the newly enlarged Du Pont Experimental Station near Wilmington. Photo Aero Service Corp.*

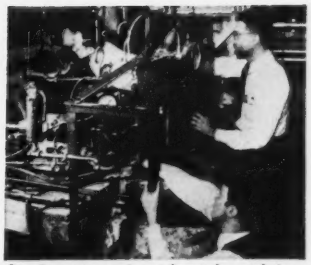
### Expanding for Tomorrow

With the expectation that still more "products of tomorrow" will come from the test tubes, flasks and stills of the research laboratory, the Du Pont Company recently expanded its Experimental Station near Wilmington. In this thirty million dollar addition, major emphasis is being given to long-range and fundamental research.

The enlarged Experimental Station with its 20 new buildings represents one of the largest and best-equipped research establishments in the world. Even so, less than half of the Company's total research personnel is situated here. Du Pont laboratories in more than 25 other locations also carry on both fundamental and applied research.

**Examining** *an infra-red spectrogram of polyvinyl alcohol in connection with the fundamental physical characterization of the polymer: J. R. Downing, Ph.D. Physical Chemistry, Illinois '40, and D. G. Pye, Ph.D. Physical Chemistry, Stanford '43.*

There are now about 800 technical people engaged exclusively in research work at the Experimental Station. Assisting them are 1,500 others, in technical and non-technical capacities. The research people represent a wide range of training. Among them are organic, inorganic, physical, colloid, analytical chemists and biochemists; physicists and biophysicists; chemical, mechanical, metallurgical, electrical and electronics engineers; plant pathologists, plant physiologists, agronomists, entomologists, horticulturists and others trained in biological science. In addition, there are specialists who are not classified in any of these groups.



**Carrying out** *experimental autoclave polymerizations of condensation polymers: J. H. Blomquist, Ph.D. Chemistry, Ohio State '41; O. A. Bredeson, Ph.D. Chemistry, M.I.T. '41; J. E. Waltz, Ph.D. Chemistry, Indiana '41.*

### Free for Research

At the Du Pont Experimental Station every effort is made to permit the research man to concentrate on research. He is provided with the most modern laboratory tools and for the construction of special equipment he can call on a wide variety of services. These include machine shops, carpentry, electrical, welding, instrument-making, and glass-blowing shops. When the research worker needs any service or equipment within the scope of these shops, it is provided for him.

At this industrial research laboratory, Du Pont scientists are devoting themselves to extending the frontiers of science and creating "Better Things for Better Living . . . through Chemistry."

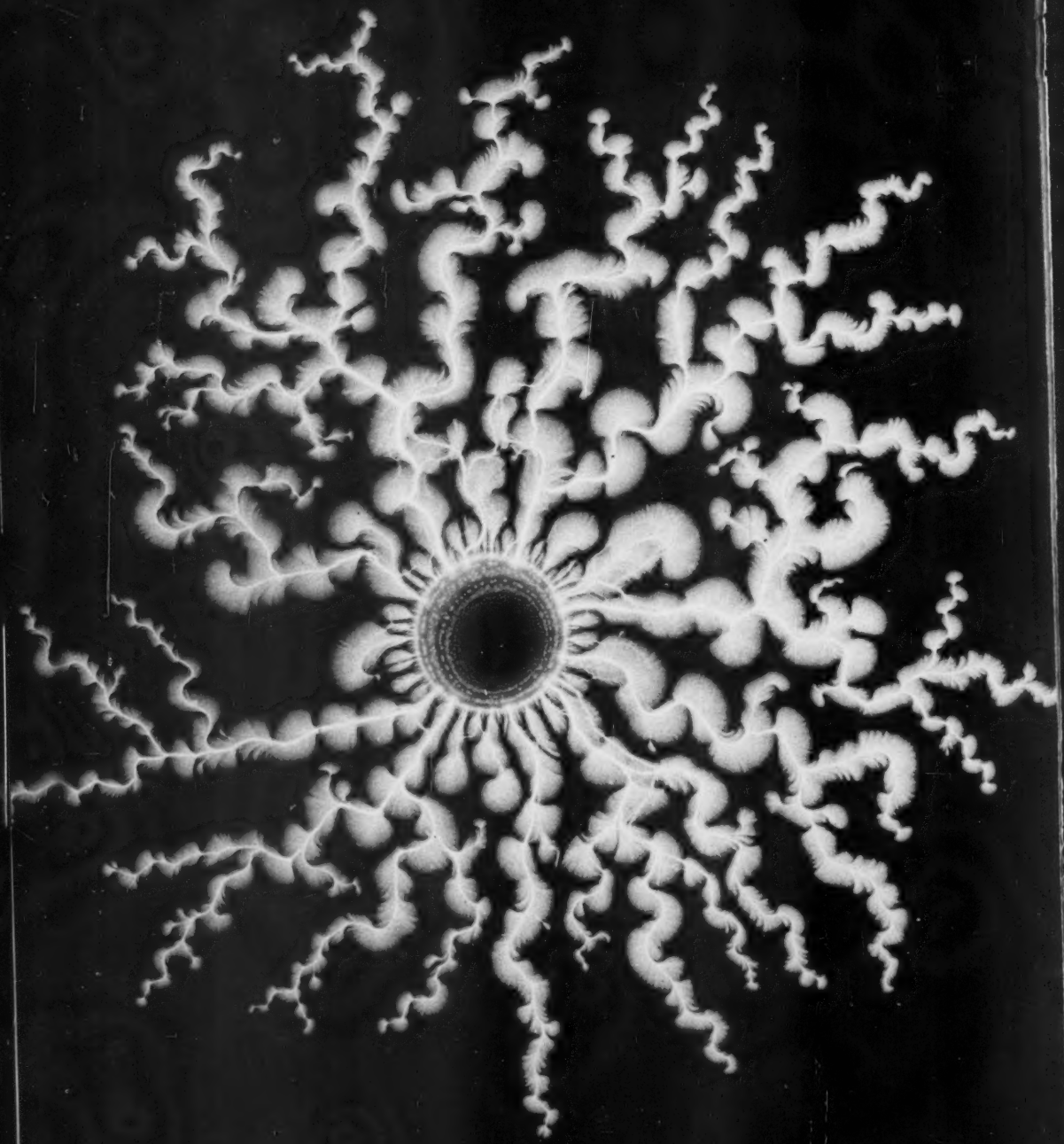
**DID YOU KNOW THAT . . .**

Nylon came out of a fundamental research program begun in 1927. However, it took 13 years and $27 million in research and operative investment to get into satisfactory commercial production.

DU PONT
REG. U. S. PAT. OFF.

**BETTER THINGS FOR BETTER LIVING . . . THROUGH CHEMISTRY**

Entertaining, Informative — Listen to "Cavalcade of America," Tuesday Nights, NBC Coast to Coast



# tech engineering news

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***FRONTISPIECE***

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# balance in american economic policy

## By Prof. Walter W. Rostow

The economic policy of the United States at home and abroad is a means to an end. That end is, and is likely to remain, the strengthening of the non-communist world against the threat offered by communist ambitions. The term strength applied in this general way to nations is, however, a complicated idea. There is military strength, political strength, economic strength, and if you like, moral strength. All these matter in the present struggle, and they are all interconnected.

Although the different forms of strength are related to one another, it does not follow that the increase in one aspect of our common strength necessarily increases the others. If we put our resources into guns and planes, we cannot put them into television sets and houses in the United States nor can we put them to the same extent as we might wish in power dams and in new factories abroad. Thus the problem confronting American economic policy is fundamentally a problem in balance. The question is: how best to dispose of our resources in various directions so as to achieve the greatest overall strength within the non-communist world.

The specific issues of balance we face in disposing of our resources can be seen if we look first at the position at home; then at the position in Western Europe; and finally at the position in the underdeveloped areas of the world with whose destiny the long-run fate of political democracy is so deeply linked.

At home we wish to achieve a high level of military strength. This is the primary national objective at the present time. We wish to do this, however, without causing inflation; without lowering too severely the standard of living of the country as a whole or of any groups within it; and without destroying the essential democratic procedures and institutions on which the country is based. And there is yet another element of balance that must be faced in making our military program. We wish to avoid building so large a military establishment that, should major war not occur soon, we would again have to dismantle it, as we did in 1945–46.

With respect to military policy a rough objective has now been set for the next several years. We wish to build a military establishment of about four million men. What the politicians and administrators in Washington are now seeking to do is to apportion the burden the building of this establishment entails. They are seeking a division of the burden acceptable to all. How shall we manage wages, prices, taxes, and farm policy so that Americans everywhere are convinced that their own contribution is fairly assessed and the country can concentrate on the positive tasks which confront it? Should the men in Washington fail, the burden will be badly distributed by the clumsy process of inflation; and our efforts will be weakened by internal quarrels.

The problem of balance at home is matched by an even more precarious conflict of objectives in Western Europe. It is the American interest to see Western Europe strengthened militarily to a point where its ground forces might be able to resist Russian land armies; to make Western Europe economically self-sustaining so that it no longer requires American gifts; and to bring Western European peoples, after their difficult experiences of recent years, back to a faith in themselves and political democracy. The question is this: how much of Europe's resources can be devoted to military purposes without endangering the carefully built but precarious recovery of the postwar years? Is it more the American interest to see an extra Western European division mobilized or to have the labor of fifteen thousand men employed in making firm the foundations of European recovery?

This is not an abstract question. It comes up in a thousand forms every day in Washington. Should we, for example, allocate a margin of scarce steel to U. S. automobile manufacturers, to U. S. tank manufacturers, to the builder of a power generator to be installed in Italy, or to the builder of a bridge for an Indonesian highway?

These questions are not easy to answer. The right balance can only be found by careful judgment, country by country. Britain can carry a heavier burden than Italy, for example, not only because it is a richer country but because it is better organized, politically more stable, morally better prepared to carry the strain.

The whole of our common military effort with Western Europe must be carried out, then, in full awareness that a real danger exists, even in so strong a country as Britain; namely, that too sudden or too heavy a military burden may set in motion an inflation and a decline in living standards which would do more to weaken strength in Western Europe than any likely number of new divisions could compensate.

Now, what about the underdeveloped countries? We are increasingly aware that over the coming decades perhaps the most important question we confront is whether the underdeveloped regions of Asia, the Middle East, Latin America, and Africa will choose to move toward some form of political democracy or toward totalitarian forms of government. Their decision is important for us because in population and in strategic location these areas constitute the balance of the world's power. It is not an exaggeration to say that whether the United States ends this century as a democratic island in a hostile world, or whether it remains a leading element in a coalition of the world's majority will depend on the decision of millions of now impoverished peoples who live in far off, underdeveloped regions. India and Indonesia, for example, have only recently achieved national status, after long struggle against the European countries which held them as colonies. Their leaders are eager to translate their national independence into a high standard of living. They believe this can only be done by rapid industrialization. They lack almost every basic condition for rapid industrialization, except the will to see it accomplished. They lack scientific knowledge; engineering know-how; capital. They lack a class of vigorous business men prepared to carry forward the task through private enterprise. Their peoples are untrained, impoverished, and often illiterate. Yet, so strong is the raw aspiration in these regions, that few would doubt that, over coming decades, great economic progress will, in fact, take place.

The issue is likely to be less whether economic progress is achieved by these underdeveloped areas than whether it will be achieved under some form of political

(*Continued on page 16*)

# titanium

## By James L. Wyatt, G.

During the past three years there has appeared a new metal on the metallurgical stage, one that exhibits such unusual properties that it has been dubbed "the wonder-metal" by those not completely familiar with its physical and mechanical characteristics. In order to judge the appropriateness of this story-book cognomen, let us examine titanium as it is known today.

Interest in the commercial production of titanium was stimulated by the military requirements of the recent world war. The United States Bureau of Mines undertook a study of feasible methods of production, since it appeared that titanium might be useful as a high-temperature material of construction for jet aircraft engine parts. The melting point is reported as 3140°F., 350° above that of pure iron. This, coupled with its relatively low specific gravity, 4.5, indicated the possibilities for Air Force uses. Of strategic importance also, there is an abundant supply of ilmenite, the major source of titanium, on the North American continent. The total quantity of titanium in the earth's crust is exceeded in amount by only three structural materials: iron, magnesium and aluminum. It is interesting to note that there is more titanium ore than the ores of all the other non-ferrous metals, such as copper, zinc, tin, lead and antimony, put together.

The Bureau of Mines concluded from its studies that titanium could best be produced using a method developed by Dr. W. J. Kroll in Germany about forty years ago. In essence it involves the reaction of a titanium halide with an alkaline-earth metal under an inert atmosphere. More specifically, magnesium metal of high purity is heated to 750°C. in an iron vessel containing an atmosphere of helium or argon. Titanium tetrachloride, a vapor at temperatures above 137°C., is introduced into the reaction chamber where it reacts with the magnesium to form titanium metal and magnesium chloride in accordance with the reaction,

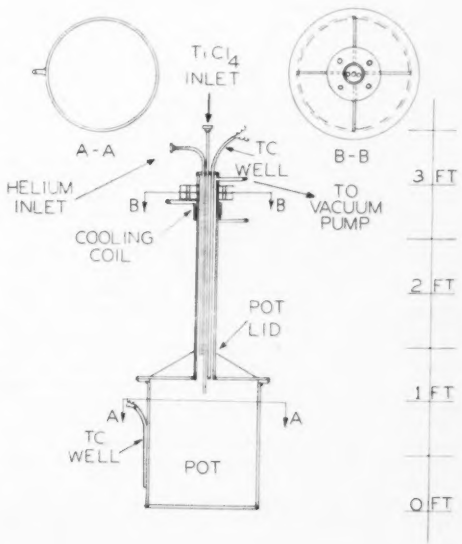
$$TiCl_4 + 2\ Mg \rightarrow Ti + 2\ MgCl_2.$$

The reaction is strongly exothermic, evolving sufficient heat to raise the temperature of the products to 1200°C. unless part of the heat is dissipated. Experimentally it has been found that titanium reacts with iron to form an alloy having a low-melting eutectic near 1000°C. This necessitates the absence of temperatures in the reactor above 1000°C., and is one of the major problems in titanium production. Control of the reaction temperature is maintained by exterior cooling and carefully regulated titanium tetrachloride flow rates. The exothermic nature of the reaction limits the rate of commercial production for a specific reactor size, and in turn limits the reactor size because of problems of heat dissipation in large-diameter reactors.

Titanium formed by the Kroll reaction is similar to a sponge in structure, the pores being filled with magnesium chloride. In the commercialized version, most of the magnesium chloride is drained from the sponge as it forms, leaving a relatively clean sponge whose surfaces are coated with the chloride.

In the National Lead Company process, chloride adhering to the sponge surface is removed by vacuum-distillation while the reaction mass is still at reaction temperature. Processes developed by the Bureau involve cooling the reaction mass to room temperature, cutting it out of the reactor on a lathe, and distilling the resulting chips in a distillation vessel as a secondary process.

Sponge recovered from the reactor is of little use until it is processed into ingot form. To date there has been found no refractory that does not react with titanium, so melting cannot be consummated by normal methods. At the present time ingots up to 12" in diameter are melted in water-cooled copper crucibles, using water-cooled, tungsten-tipped electrodes. Standard welding machines have proved the most feasible source of power for the melting operation.




**Titanium Metal Reactor of the type developed by the U. S. Bureau of Mines.**

Once titanium has been obtained in ingot form, production of commercial shapes is easily accomplished. It has been found that the procedures normally used for stainless steel fabrication are completely suited for titanium, except that rolling and forging temperatures are about 200C. degrees lower. To date every commercial shape has been produced from heavy plate to foil 0.002" thick, rounds from 12" diameter to 0.1 mil wire, and tubing down to capillary dimensions. No method has been developed for producing castings, or even of melting large enough quantities of titanium for a casting. Carbon crucibles have been used for melting titanium, but properties of the resulting metal are very poor due to alloying of carbon and titanium.

(*Continued on page 16*)

# red arrow

*An Ideal Transport System*

## By David L. Klepper, '53

Most American cities and towns are plagued with both traffic congestion and an ailing public transport system. These are twin problems which will be solved by a good transit system; people will ride a healthy transit system and fewer will drive their own cars; traffic congestion will be reduced, for a person riding a public vehicle uses far less road space than one driving his own automobile. The ideal transport system, then, encourages everyone to ride transit and not drive. Red Arrow Lines, a transit system regarded by many in the industry as one of the finest, does just that, pays taxes and earns a profit too.

This system comprises Philadelphia Suburban Transportation Company's rail and bus routes and the Philadelphia and Western Railroad Company's high speed rapid transit line and feeder bus routes operated by the subsidiary Main Line Transfer Company. Hub of the system is the large 69th Street Terminal on Garrett Road in Upper Darby, which replaced the old Terminal in 1936. Standing in the concourse during the evening rush, one may watch the crowds of people emerging from the Market Street Elevated platforms, hurrying past concessions and the travel bureau to the bus and rail car loading platforms. Here cars and buses are lined up for loading, having discharged their passengers previously at the unloading platforms on the other side of the paved bus loop and platform. The destination of each car and bus is not only indicated in the wide destination signs on the vehicles, but also on bright, changeable signs located above the wide platforms. Aboard the modern, streamlined, maroon car loading on the right hand track, with destination sign marked "Westchester, Express to Westgate Hills," one may usually find an empty seat in the green interior. Expresses run only during rush hour, not for additional speed but to relieve overcrowding on long distance cars.

At exactly 5:30, right on schedule, the last passenger steps into the car, the front and rear doors close, and the car moves quietly down the platform. Across the platform a Media Express car is moving parallel to us; two cars are dispatched simultaneously for minimum traffic congestion at the street crossing serving as the terminal's throat. The Media car slips sharply to the left, away from us on the trunk line to Drexel Hill, while we run straight down a reservation in the middle of West Chester Pike. As the car leaves 69th Street, one can get a brief glimpse of the Philadelphia and Western line, perhaps a two car "bullet" train leaving 69th Street for Norristown. Making no stops, the car proceeds at moderately high speed through the congested shopping area that has grown up around the Terminal. Soon the car reaches the suburban area, accelerating up the long hill to Ardmore. Frequently, cars going down the hill are passed; many of these are the older two car center entrance trains operated only during rush hours. Many have had leather seats installed, and in their new paint scheme they do not appear at all old.

We reach Llanerch, where the center entrance trains diverge to the right on their run to Ardmore. Cars

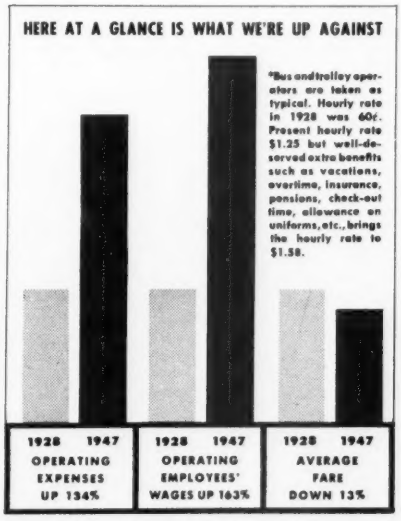
*Red Arrow Photo*

**A postwar General Motors 45-passenger Deisel bus loads rush hour crowds at 69th Street Terminal.**

**The new garage, completed in June 1950 on Philadelphia and Western Railroad property near 69th Street Terminal, serves Red Arrow and Main Line Transfer Company.** *Newton H. Hartman Photo*

### *Average Fare Now Is Less Than 1928*

That's hard to believe. Yet it is true. Despite the higher costs of everything we buy, everything we do, the average fare paid to Red Arrow Lines—either bus or street car—is less than twenty years ago.


HERE AT A GLANCE IS WHAT WE'RE UP AGAINST
*Bus and trolley operators are taken as typical. Hourly rate in 1928 was 60¢. Present hourly rate $1.25 but well-deserved extra benefits such as vacations, overtime, insurance, pensions, check-out time, allowance on uniforms, etc., brings the hourly rate to $1.58.
1928 1947
OPERATING EXPENSES UP 134%
1928 1947
OPERATING EMPLOYEES' WAGES UP 163%
1928 1947
AVERAGE FARE DOWN 13%

stopping at Llanerch connect with two bus routes here, which come from 69th Street by a longer route. The Ardmore cars connect with many more at Ardmore terminal, and service is well coordinated. Red Arrow bus traffic has increased enormously, and for this traffic Red Arrow has a large fleet of modern, postwar, General Motors buses, and a number of prewar smaller buses. These buses used to be serviced at a garage next to the rail car shops at Llanerch, but repairs and servicing are now taken care of at a spacious new bus garage near the 69th Street Terminal, built on land next to the tracks of, and owned by, the Philadelphia and Western Railroad, shortly after Red Arrow management of this rapid transit line began. Main Line Transfer Company's buses are also repaired and serviced here. Located nearby are the rapid transit car shops, where P. & W.'s high speed "bullets," and modernized older cars are kept clean and serviced.

Our car on the West Chester line, and all other Red Arrow trolleys, are maintained and receive daily (yes, daily!) inspections at the rail car shops located just north of the Llanerch junction. Here, also, the rail cars are frequently washed and receive regular overhaulings; and here the older cars received their new paint scheme and comfortable leather seats. The white walls sparkling under fluorescent lighting testify that Red Arrow's management knows that to have clean cars a transit system must have clean shop facilities.

The smoothness of motion of our car, as well as its cleanliness, give tribute to its excellent maintenance; for, after passing the dispatcher's office in front of Llanerch car house, the car speeds over fifty m.p.h. for the run to Westgate Hills. Despite the high speed for the trolley, there is little vibration or noise. None

**Rush hour express on the West Chester Pike near Rittengouse Road. Cars are postwar St. Louis built.**

of Red Arrow's thirty-four lightweight, high-speed rail cars are equipped with the rubber resilient wheels that are standard for noise reduction on all modern city streetcars; their quietness may be attributed solely to sound construction and proper maintenance. The cars used on the West Chester line, and on Ardmore during non-rush hours, built by St. Louis Car Co. in 1949, do make use of the automatic accelerator that permits the modern trolley to adhere to such high speed schedules as Red Arrow runs. The 1931 lightweights, replaced in regular service by the newest cars, and the streamlined 1941 cars used on the Media Division were built at the nearby Brill plant.

Westgate Hills is a typical example of the beautiful suburbs that lie along all Red Arrow rail and bus routes. Anyone looking out the window as the car makes stops to unload passengers will find it difficult to realize that not very long ago the area was open farmland. In those days the rail line was known as the Philadelphia and West Chester Traction Co., and large, heavy interurban cars were just beginning to bring people to the area. Many were the Sunday car riders who later returned to settle along the car lines. However, if the rail lines opened up the area; it was the bus lines that gave its growth impetus. The traction company began operating bus routes, under the subsidiary, Aronimink Transportation Company, in 1923. Today, the seventeen bus routes are operated directly by the Transportation Company. These bus routes furnish transportation between and across the suburban areas, as well as to and from Philadelphia and, although no single bus line is as important as any one rail line, passengers riding the buses paid in a total of over four hundred thousand dollars in 1947, twice the total amount collected on the rail cars. To cope with the still increasing bus patronage, fifteen General Motors 45-passenger, Deisel, hydramatic buses are scheduled for delivery in August.

Before reaching Larchmont, fares are collected from the passengers as they leave; at that point only a seated load remains, so the conductor walks back through the car collecting fares. We find it costs 40¢ to ride to West Chester; that's not bad, however, for over sixteen miles. Most passengers pay 12¢ or an 11¼¢ token for a one-zone fare.

(*Continued on page 18*)

**A single Philadelphia and Western "bullet" speeds past Beechwood Station. These cars are capable of 80 m.p.h. Built by Brill in 1929, they are the earliest of rail streamliners.** *Red Arrow Photo*

# faith in science

## By I. I. Rabi

*This article is reprinted from the January 1951 issue of* THE ATLANTIC

I

Mankind is puny and feeble under the heavens as long as it is ignorant. It is ignorant in so far as it is self-limited by dogma, custom, and most of all by fear — fear of the unknown. To science the unknown is a problem full of interest and promise; in fact science derives its sustenance from the unknown; all the good things have come from that inexhaustible realm. But without the light of science the unknown is a menace to be avoided by taboo or propitiated by incantation and sacrifice. The scientific tradition rests first of all on a faith in mankind, in the ability of humans to understand, and ultimately, within certain limits, which are in the nature of things, to control, the environment in which we live in all its aspects: physical, biological, and social.

This optimistic faith has always permeated and energized the American way of life. The scientific tradition should help us to renew and reaffirm our faith. In recent years, however, ominous symptoms of moral hypochondria have disturbed the development of our institutions. Under the threat of impending conflict with the Russian empire some sections of the public have reacted with blind, irrational fear. The action of Congress in overriding the presidential veto of the anti-Communist bill and the arrogant dismissal of a large number of professors by the regents of the University of California are the newest examples of what I would call moral hypochondria. A healthy awareness of grave danger should lead to clear, considered, decisive action. Hysterical fear results in the setting up of taboos around emotionally charged words and symbols. The real objective, security for the free development of our institutions, becomes hazy and possibly perverted when panic takes over.

The greatest enemy of the scientific tradition is superstition. By superstition I do not mean merely a belief in goblins, gremlins, and the malevolent power of Friday the 13th. The superstition which is completely incompatible with the scientific tradition usually comes as a plausible system of ideas founded on premises which defy exact formulation. They may be words without a definite meaning or inferences from events inexactly described or unique and non-repetitive.

An attempt to study a superstition in an external, objective fashion usually encounters emotion and often physical opposition from its proponents. Mankind seems to have a genius for the invention of superstition. As science advances, superstition makes more and more use of the terminology of science; it becomes in fact a parody of the scientific method, a deft mixture of the true and the false, which often has a fatal fascination.

The best examples of this sort of thing can probably be found within the realm of the Soviets. The whole Nazi movement in Germany was founded on this kind of superstition. Superstitions arise everywhere and there is no force which can hope to combat them successfully except science.

Even science itself has not been wholly free from superstition. Science strives for understanding, but how can one distinguish understanding from mere plausibility? The scientific tradition, although affirmative in spirit, polices itself by a profound skepticism. There are many examples where scientists have made mistakes, where they have been fooled or have fooled themselves. However, all their work passes under the scrutiny of friendly but skeptical minds.

Individual authority no longer possesses any force in the scientific tradition. No scientist, however great his renown, can mislead his fellow scientists for longer than it takes to check his observations or verify his conclusions and their consequences. Whether the individual scientist acknowledges his error or not is of little consequence as long as the tradition is kept pure. Controversy and polemic are now outmoded forms of scientific publication except possibly within the Soviet Union. Even there the appeal is hardly meant for fellow scientists.

I dwell on this point not only to show something of the reason for the great authority of established scientific doctrine, but also to indicate the way of life of science when it is free. If some of the customs and tradition of science could be transferred to the halls of our Congress or the United Nations, how beautiful life could become.

It is a truism to say that the application of science to technology is the basis of modern life in the United States. I refer not only to the products in everyday use, from the automobile parked in the street to the detergent in the kitchen, but more to the living social integration of our economy. Cut a relatively few electric power lines and the larger gasoline pipes which cross the country from west to east and south to north and keep them cut for a while. The effect on the life of the country would be like a thumb on the windpipe of a baby. Even the proud independent farmer would be unable to cultivate his acres without gasoline. His horses are gone and his wife is not inured to pulling the plow.

The development of new means of communication, production, transportation, and control have not merely added new possibilities to an existing way of living: they have so altered our basic patterns of organization that national life as of today would be impossible without them. We consider ourselves exponents of individualism and free enterprise, and national planning is on the whole unpopular. Yet we live under a degree of integration of social effort comparable to that of the cells in our bodies. I doubt very much whether we would have dared to build a social structure which is so vulnerable to attack from without, and to social disorganization from within, if it were actually planned from the very beginning.

On the other hand, if we consider the assimilation of science into our way of thought we find that our general public — and even our educated public — is as ignorant of science as a healthy Hottentot is of physiology. We are like the city boy who likes milk but is afraid of cows.

It is one of the paradoxes of our age that our general

(*Continued on page 24*)

# school goes on

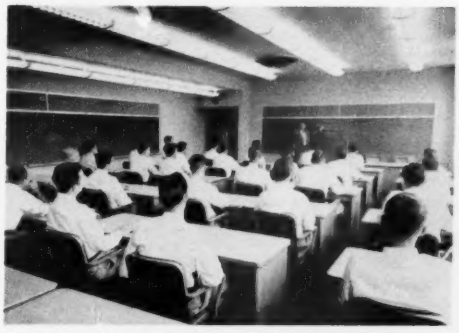
## By the *T. E. N.* Staff

The training of engineering graduates to take specific jobs in industry does not end nowadays with the acquisition of a sheepskin. Most industries have instituted training programs of their own to facilitate the transition of the new engineer from student to worker status. Outstanding and a pioneer in student training is Westinghouse.

Westinghouse started lectures for recently hired graduates in 1902. In those days the students attended class for two hours a day after ten hours of work in the shop, and were paid sixteen cents an hour for their efforts. Now the wages are slightly higher, the hours shorter, and the locale for learning is greatly improved over the original room over a store.

**The downstairs lounge. Talk predominates here.**

**Typical classroom. Note the modern lighting.**



In the fifty years of operation of the Graduate Student Training Program at Westinghouse, fifteen thousand students have benefited. So the thing is really of sizeable impact, and has served as a model for other companies. To get specific, the Westinghouse program goes like so. There is a week of classes devoted to orientation, then six more weeks studying the products of the company. Then the novice tours several plants on work assignments, still acquainting himself with the company in its broad aspect. This basic training (I hesitate to use such a term) lasts four or five months.

**The new Westinghouse educational center in Wilkinsburg, Pennsylvania. Here are the classrooms and lounges for engineer trainees.**

At this stage in the game, company and worker-student recall why worker-student is around anyway, and the long life of toil begins in earnest. But not without some more after-hours book work in the delightful surroundings here depicted. That is, study is now directed toward the special field of that our novice expects to tackle.

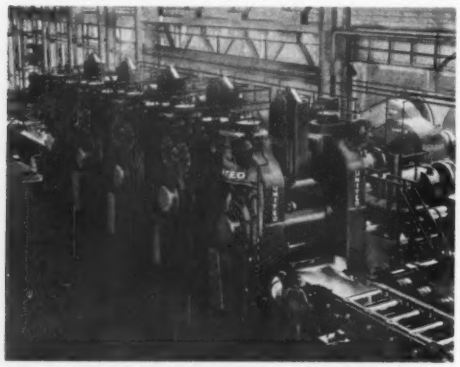
The classroom work is just like school, with perhaps a few more aids such as movies and demonstrations. Certainly the facilities are modern and complete. There is allowance made for goofing off; this phase is supervised by an organization called the Graduate Student Club. The transition from school to industry must be made gradually you know.

**The main lounge. Pretty nice.**

# life processes of a cold mill

## By Frederick G. Stengel, '52

The productive capacity of the United States steel industry exceeds that of the rest of the world. Our open hearths, blast furnaces and Bessemer converters turned out ninety million tons of steel in 1948, and our capacity is expected to exceed one hundred million tons by 1952. This raw steel in the form of raw ingots, slabs, etc., passes on to rolling mills, tube mills, structural mills, rail mills, cold mills and a long list of other mills and factories to give us steel in its finished forms.



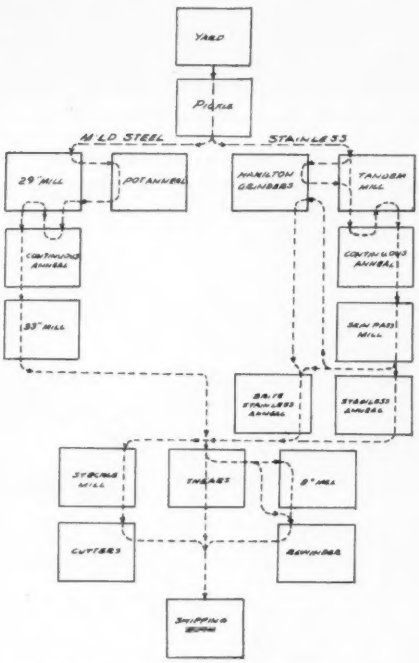
**A typical installation of five mills "in tandem."**

Initially all steel from the open hearth or converter must be hot worked to reduce it to sizes that are easily handled, and eventually most of it must be cold worked to give a presentable finish plus desired mechanical properties. Of all the steel products that flow out of our myriad mills and factories, approximately twenty-five per cent by weight have been finished by cold rolling into strip and sheet form. Look around you — refrigerators, auto dash trim, typewriter key rings, stainless steel silverware, and so on ad infinitum — all cold rolled products.

The rolled strip and sheet is produced in "cold" mills which receive their raw materials in the form of large coils of steel often weighing as much as twelve thousand pounds. The operation of such a mill is a very specialized and fascinating business, employing many involved techniques necessary to put out the highly controlled products which must meet exacting specifications as to hardness, gauge, tensile strength, and associated physical properties.

The first operation that must be performed on a coil of steel that comes out of the storage yard is pickling to remove rust, scale, and any dirt that has accumulated in transport. Formerly, this was done by laying the coils in vats of acid and letting them expand much in the manner of a watch spring. This was a slow, dangerous process, and not very effective. At present, however, the pickling is done in a continuous process which is much faster and more efficient. The coil is placed on the pay-off or front reel and spot welded to a leader which is threaded through various acid and wash vats and pulling or "pinch" rolls to the take-up or end reel. The coil, which is many thousand feet long, is pulled through, cut from the leader and locked on the take-up reel. The reel and pinch rolls are then adjusted to pull about twenty feet per minute, and from then on the process is completely continuous, the next coil being spot welded on the end of the preceding one. Since there are several reels at each end, at least two strips can be run simultaneously. The pH of the acid is checked daily, since too great an acidity will cause mechanical failure during subsequent cold rolling. Too low an acid concentration is not desirable either, since the steel pickles too slowly. Two tubs of acid are used, the first one doing most of the heavy work. The acid in these tubs is heated to 190° F. by live steam which is injected under the surface. A commercial inhibitor is used to prevent surface attack on the metal by the acid.

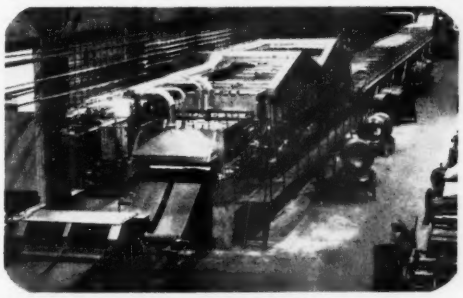
After pickling, all mild steel goes to some large primary mill, while the stainless steel which is received in narrower widths goes to a tandem mill for rolling. The primary reduction mill has a single structure four rolls high, with the top and bottom ones driving the smaller work rolls, which are actually in contact with the steel. These work rolls bear the brunt of the work as the mill roars into action, running at 400 to 800 feet




SIMPLIFIED FLOW SHEET FOR TYPICAL COLD MILL OPERATION

per minute, and hence must be changed at frequent intervals. "Breakdown" rolls, which are used for heavy duty rough rolling, will last a couple of days. When finished gauge is neared, the rolls are changed every few hours when surface defects become apparent. Since several passes, or runs back and forth through the rolls, are necessary to produce the desired reduction in gauge, the mill is reversible, meaning that either reel can supply the power and pull the steel through the rolls with the help of the back-up rolls. An average reduction in one pass is ten per cent of the cross-sectional area. After several passes, amounting to a total reduction of ninety per cent for mild steel, the strip has become so work hardened that it must be annealed before it can be rolled further.

Generally the mild steel is first subjected to the pot or box anneal, which formerly was the only available means. It is rather slow and gives a fully softened, but warped product; hence it is now used for rough work or when a full anneal is desired. The coils are stacked flat on small cars, covered with light sheet steel covers to protect them from the direct action of the flames, and pushed into the huge pots or boxes for treatment. The coils are annealed for twelve to twenty-four hours after the annealing temperature is reached throughout the charge. The heat is then cut and the coils allowed to cool. In current practice, most of the steel so treated is process annealed in either electric or gas-fired bell-type furnaces where it is stacked in rolls



**Mild steel annealing or normalizing furnace with a capacity of four tons an hour.**

and covered with an "inside" steel cover. The "inside" cover contains atmosphere that is as close to deoxidizing as possible, and neither carburizing or decarburizing. The large bell type furnace cover is placed over the inside cover and the charge is thus heated by radiation and convection. Cooling is hastened somewhat by running water over the inner cover after the outer bell has been removed. This type of furnace is more efficient than the older box type. The variety of conditions required for the different steels makes annealing a complex operation.

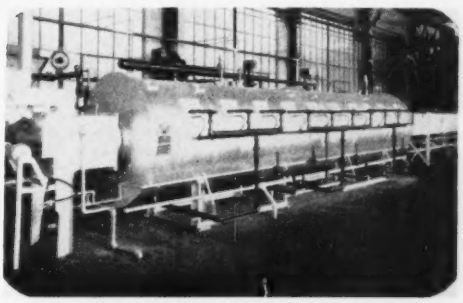
When the mild steel is nearing its final thickness it is given a shiny finish by annealing in a continuous furnace. This mammoth machine, capable of handling two strips simultaneously, has a combustion chamber a hundred feet in length plus a cooling section which is considerably longer. It is fueled by butane and air, which have been previously combined in some definite ratio in a pre-mixer. The strip is in direct contact with the flames, but due to a deoxidizing atmosphere, the surface of the metal is not affected and remains bright. When the strip emerges from the furnace section, it enters the cooling portion which is made air-tight to prevent oxidization of the metal while it is cooling. As a contrast with the speed of the rolling mills, this furnace operates at a speed generally not exceeding fifteen feet per minute. After annealing, the steel is rolled to its desired temper or hardness on some lighter skin-pass mill or sent to the shears or cutters prior to shipping.

All the stainless steel is annealed by continuous processes, but since there are thirty different types of stainless steels requiring vastly different treatment, many varied techniques must be used. Since stainless is generally handled in narrower widths, the furnaces can handle as many as three strips at a time. Two main types of furnaces are used to produce the different finishes required. Both use butane as a fuel, but one

**Typical four high reducing mill.**

furnace uses cracked anhydrous ammonia to provide an inert atmosphere and produce a bright finish on the strip. This bright anneal furnace has a ninety-foot tube through which the steel passes, protected from the direct action of the heat by the cracked ammonia atmosphere. The result is a steel of very high finish suitable for such uses as silverware and trim.

Another type of furnace does not give a bright finish, but rather a shiny surface that is still suitable for many specialized applications. Since in this furnace the strip passes directly through the flames and is exposed to the action of the air, it emerges from the



**Stainless steel bright anneal furnace with special anhydrous ammonia atmosphere.**

furnace with a heavy oxide coating contaminated with impurities. This coating is then removed by electrolytic pickling and acid baths, depending on the type of stainless.

When the steel has reached a point where it is close to its final gauge and is just below its desired hardness,

(*Continued on page 30*)

# tech engineering news

Professional Journal of the Undergraduates of the
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# from the editor's notebook

It is one of the guiding ideas of Wiener's *Cybernetics* that science and thought in general would not suffer by a coming together of the specialties. That mathematicians and communications men and physiologists can work together to solve problems out of the reach of the individual specialists.

The idea is probably not new, but it has value. The theory is something like this. The study of a particular set of phenomena is quite often the outgrowth of the life work of a great man. This man in a sense has set the precedent for future work in the field, in that his approach will be adopted by and large by those who follow. In other words, there grows up a tradition — a traditional theory, a traditional approach, a traditional technique, the sum total of which constitutes a speciality. Now a virtue of science is that this tradition can be highly modified in the light of new evidence and simpler explanations, but the tradition exists and the record shows that it can be a reactionary force, as in the case of relativity, and the quantum theory, which were only begrudgingly accepted by some.

Now it is really the divergence and dissimilarity of the traditions which accounts for the existence of twenty different fields of study at M I. T. In fact, it is tradition which prevents the complete unity of all study of natural science. From this point of view we are inclined to look at specialization as a hindrance. On the other hand it is plain the development of techniques and traditions which conform somewhat to the special nature of the problem has borne fruit; in some cases very large and edible fruit.

But it is time, the theory goes, to again make contact. For the traditions are not as inapplicable outside their original domain as most people think. In fact, Wiener's successes lend support to the hope that cross fertilization of seemingly divergent techniques would be highly productive.

There are indications that the idea of cross fertilization is making headway. First, the Institute has long sponsored interdepartmental laboratories for the cooperative study of phenomena lying between fields — the Acoustics Laboratory and the Research Laboratory of Electronics, for instance. Second, the Institute recently gathered together a group of experts into what was called the Lexington Project, for the purpose of solving a broad and difficult problem for the Atomic Energy Commission. It may be said that the results were gratifying. Thirdly there is evidence that engineering and applied problems benefit from this treatment as much as pure research. The Armour Research Foundation, a large laboratory doing applied industrial research, works on the basis of the team approach. There are research teams consisting of a variety of experts. The teams tackle problems with a coordinated effort, and the results are good.

So far there has been linking only between approaches not widely different; as the idea takes hold it would not be surprising to witness a large scale broadening of coordinated research. For the fact is that government and industry is paying and they want efficiency.

G. B. F.

## About Our Authors...

**Professor Rostow** of the History Department speaks from experience in the E.C.A. **Dave Klepper**, a Course VI Sophomore, again writes on his full time hobby of metropolitan transit. **Jim Wyatt**, just arrived to do graduate work from the National Lead Company, has done work for them on the practical problems of titanium. **Dr. Rabi**, a professor of physics at Columbia and a Nobel prize winner for his work in molecular beams, has admirably stated the usually unspoken tenets of scientific research, it seems to us. **Fred Stengel** also writes from practical experience. As a sophomore metallurgist, he worked during the summer for Wallingford Steel Co. and has seen the monster mills in action.

## american economic policy

(*Continued from page 6*)

democracy, or under Communism, or under some other form of dictatorship. It is the aim of American policy to use our resources, leadership, and influence to help lead these backward areas towards higher standards of life under political democracy. This is no easy task. The failure of political democracy in China, at this stage of its history, is a warning of the dangers; for these backward areas, long impoverished, long subject to one form of tyranny or another, will not move swiftly or easily toward forms of government we would regard as democratic. In the historic American effort to which we are now committed, to see if we can help to guide these areas towards democratic economic development, our wisdom and resources will be tested. No aspect of American policy offers, incidentally, more challenging problems for the engineer, who may prove to be a key ambassador of the American interest, in the Fourth Point Program.

It matters, therefore, how much of America's resources are now devoted to aiding the development of these regions and how wisely they are used; and it matters to what extent the pursuit of our military objectives is made consistent with the economic and political aims of these regions.

In short, the present American military effort must be balanced against — or better, made part of — important objectives of stability and progress at home, in Western Europe, and throughout the underdeveloped portions of the non-communist world.

Fortunately, some aspects of the military program tend to harmonize with our wider aims. For example, the American need for imported raw materials has raised the dollar earnings of certain European countries as well as some of the underdeveloped regions. The high level of employment and income in the United States has made it somewhat easier to sell European manufactured goods in the United States. In general, then, for the time being, American rearmament has narrowed the world's dollar gap. It has also, however, raised the prices of fundamental raw materials and tended to set in motion in Europe dangerous inflationary forces. Furthermore, the increased need for basic raw materials may lead to investment in underdeveloped countries which, if properly carried out, might strengthen their whole economic development. Here a great deal will depend on whether the economic development of these areas is kept in good balance or whether it is concentrated on requirements which may prove transitory and which may result, therefore, in a painful distortion of the world's economy.

There is a wider sense in which the strains set in motion by our present efforts can be turned to the common advantage. We all know from our national experience, that the successful meeting of a great emergency, shared by all members of the community, can lead to a strengthening of understanding and to a heightened sense of common purpose. Whether the meeting of an emergency has that constructive result or whether it results in conflict among various groups in the community depends largely on the wisdom of political leadership. For example, the effort to develop in Western Europe an effective military force could result in a higher degree of cooperation among the European states, an increased confidence in themselves and in the principles for which they stand. Under the best of circumstances European rearmament might lead to a strengthening of European societies in a wider and perhaps more important sense than purely military strength. It is clear that General Eisenhower has this large aim firmly in view. He knows how much of the best international collaboration of the postwar years had, at its foundations, the successful joint operations of the Second World War, not least in his own headquarters, SHAEF.

It is possible, also, that this emergency could strengthen our relations with the underdeveloped portions of the world. Their resources are badly needed and their location makes them of the highest importance to the non-communist coalition. If the present crisis is to result in a strengthening of these wider aims of American policy it can only do so if we never lose sight of the fact that military strength, whatever its great importance, is not an end in itself; and that the pursuit of military strength must be harmonized with the creation of healthy democratic societies in the widest sense of that term.

The need for this wide perspective is evident if we look ahead even under the worst assumption; namely, that a major war with the Soviet Union should break out. In order to fight such a war successfully we would have to fight as a member of a world-wide coalition. And when such a war had been fought and won, what would be our objective in a new peace? It would be, certainly, very much what the aim of our foreign policy is at present; that is, to see established in maximum areas of the world, conditions of economic progress under political democracy. We seek this objective for no soft-headed reason. We seek it because we know that the maintenance of this island-continent as an isolated minority center of democracy in a hostile world would, under twentieth century conditions, be so difficult and costly, if indeed possible at all, that our full strength must now be used to prevent, if possible, such an outcome to the history of this century.

## titanium

(*Continued from page 7*)

Contact for 30 seconds is sufficient to add up to 1% of carbon, which embrittles the titanium beyond use.

Commercial purity titanium, containing small quantities of oxygen, tungsten, nitrogen, iron and chlorine, has an ultimate tensile strength of about 75,000 psi, 65,000 psi yield, and from 150 to 175 Brinell hardness. Elongation values near 30% are typical of this material. It may be cold-worked, hot-worked, annealed and treated much the same as commercial low-carbon steel.

One of the major alloys of titanium contains 2.8% chromium, 1.3% iron, small quantities of oxygen and nitrogen, and the remainder titanium. Properties of this alloy are 151,000 psi tensile, 139,000 psi yield, 18% elongation, 48% reduction in area and 325 Brinell hardness. This alloy has been tested at elevated temperatures, and has withstood 65,000 psi at 700°F. for more than 3,000 hours without rupture. At 800°F., the allowable stress drops to 30,000 psi for equivalent results; values decrease drastically above this temperature.

Mechanical properties of titanium are truly outstanding. If one compares metals of equivalent purity, titanium is 10% stronger than iron; more important, however, its yield strength is 2½ times that of iron. If one compares values of strength/weight, the ratio for titanium is 4½ times that of iron. The endurance ratio is 0.80, highest of any metal. Titanium has the highest electrical resistivity, lowest thermal conductivity and lowest coefficient of thermal expansion of any commercial metal. These unusual properties indicate that

(*Continued on page 18*)

# EVER HOLD HANDS LIKE THESE?

They're not soft and warm, these hands. They're hard and cold — and mechanical. They work at the Oak Ridge atomic energy plant, preparing radioactive isotopes for shipment to Bell Telephone Laboratories and to other research centers.

These isotopes — which serve as tracers — are used by Bell scientists to study the materials that go into the telephone system. Our research men, working with Geiger counters, are able to detect wear in relay contacts, impurities in metals, the penetration of preservatives in wood.

This new research tool helps us to learn more in less time, helps us to make telephone equipment even more rugged and dependable. That's especially important right now when the Nation relies on the telephone to help get things done.

BELL TELEPHONE SYSTEM

**BIG AUSTRALIAN PACKING PLANT**

**INSTALLS Frick Refrigeration**

The Queensland Meat Industry Board recently installed three Frick ammonia booster compressors for producing low temperatures at the Brisbane Abattoir. The Board says these big machines, each with four cylinders of 15" bore and 10" stroke, "have worked very efficiently," and have increased the output of the freezers at Brisbane by 26%. Annual capacity of the plant now approximates 250,000 cattle, 150,000 calves, 50,000 hogs, and 700,000 sheep and lamb.

Whether you're in Augusta or Australia, if you need air conditioning, refrigerating or ice-making equipment in commercial or industrial sizes, there's a Frick system to meet your requirements. Ask for recommendations and estimates.

Two of Three Frick Compressors at Brisbane

*The Frick Graduate Training Course in Refrigeration and Air Conditioning, Operated over 30 Years, Offers a Career in a Growing Industry.*

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## titanium

(*Continued from page 16*)

titanium will eventually find many uses that are not currently contemplated.

Probably the most important property of titanium is its exceptional resistance to corrosion. The United States Navy has carried on extensive research projects in this field, and reports that titanium is completely resistant to sea-water, ocean atmospheres, and saline solutions in general. The most apt comparison is that titanium is equivalent to platinum in this respect.

Resistance to corrosion is not limited to sea-water; it has successfully withstood atmospheres of all industrial areas, and direct contact with chlorine gas, most acids, bases and commercial reagents in the chemical industries.

The only deterrent to widespread usage of titanium at the present time is cost. Currently sponge titanium is quoted at $5.00 a pound, and commercial shapes may be obtained at from $7.00 to $35.00, depending on the quantity and dimensions desired, per pound. Into the cost of sponge go $0.40 for magnesium, $2.80 for titanium tetrachloride, $0.15 for helium. The remainder consists of one man-hour of labor and amortization of equipment and profits. On the present scale of production, profits are still on the red side of the ledger, but there are indications that tonnage production will improve this condition considerably. Current production amounts to about 100,000 pounds a year, and contemplated production for 1951 will exceed 1,000,000 pounds.

One could list many pages of uses for titanium or titanium alloys, even at current prices. Because of its very high strength-to-weight ratio, the aircraft industry undoubtedly will be the largest consumer. The Air Force contemplates using between 75 and 100 pounds of titanium in each of its jet engines, in the form of turbine wheels in the second and third stage impellers. Firewalls will be used in combat planes, resulting in a very large weight saving over the present stainless steel varieties. It has been said that a pound of weight saved in a military aircraft is worth $10,000, so the high price of titanium is no criterion for its use. Pratt-Whitney has successfully used titanium pistons in their largest reciprocating engines, and report that they are in many ways superior to aluminum. Pitting, a serious source of piston wear in aluminum, is non-existent in titanium. Further, due to its increased strength, a 5.3 pound aluminum piston is replaced with a 3.4 pound titanium piston. This same property will allow much higher compression ratios, and result in lower bearing stresses throughout the engine. It all adds up to longer engine life and less maintenance.

Army ordnance would like to make every piece of its equipment from titanium, since the big emphasis is equipment transport by air. When iron is replaced with titanium, a 40% saving in weight is realized, which means a lot when air transport is used.

Hundreds of commercial and military uses have been proposed in an article by O. C. Ralston. Anyone interested may refer to it in *Industrial and Engineering Chemistry*, volume 42, February, 1950. It is not within the scope of this article to list them, but suffice to say that when and if titanium is produced for a price competitive with stainless steel, an industry the size of present-day aluminum will exist. Titanium, the so-called wonder-metal, will then have come of age.

## red arrow

(*Continued from page 9*)

After holding the line on fares throughout the war years, the management asked for adjustments in 1947. The base fare was held at 10¢ a zone, but discounts and the two-zone 15¢ fare were dropped. It is notable that, unlike so many transit systems, Red Arrow took care to explain to its patrons the need for the fare raise.

Rising costs of materials and labor are plaguing all transit systems including Red Arrow. Little can be done to reduce expenditures other than by effecting operating economies, and the management has no intention of letting its employees suffer because of the rising costs of living. Labor relations on the system have always been excellent, and remain so today. The operator of a public vehicle is the producer, distributor, and salesman of the industry's product; transportation, and it is most important that he be happy with his job. To insure courteous and efficient service the management has instilled a sense of identification in its employees with the management and the company. This is accomplished largely by the fine employee magazine, *Red Arrow Lines News*, and by the employee training program.

Not only does this sense of identification reach the employees of the system, but extends to the patrons as well. This is due to the fact that everyone connected with Red Arrow resides in the area served by its lines; and, therefore, is intimate with its customers. A. Merritt Taylor, who built up the Red Arrow Lines, after coming to the management of the Philadelphia and West Chester Traction Co. in 1899, developed the real estate of a number of towns on the system, and was, therefore, in a good position to coordinate the development with the transit lines. This trend con-

(*Continued on page 20*)

# *Bad News for Bugs*

BUGS are in for the surprise of their lives. *They're going to zoom into allethrin, the new insecticide ingredient. It looks like especially bad news for many of the insects that pester you most.*

Take flies, mosquitoes and gnats . . . allethrin's paralyzing touch searches them out . . . delivers the blow that knocks them down fast . . . leaving its slower acting companion ingredients in the spray or powder to complete the kill.

Until now this type of insecticide came from flowers picked by the natives in Asia and Africa. But *allethrin is an all-American product,* synthesized under scientific controls and has the definite advantages over importations of uniformity in strength and quality.

It is only natural that the people of Union Carbide pioneered in the production of allethrin on a commercial scale. For they were already making most of the needed chemical ingredients.

As a result, the people of Union Carbide are already providing allethrin in ever-increasing quantities to manufacturers of household and dairy sprays. And researchers all over the country are now engaged in testing its value for the control of agricultural pests and for other purposes. Other Union Carbide chemicals are important ingredients in many other insecticides and fungicides. One or more of them may have a place in your future plans.

**FREE:** *Learn more about the interesting things you use every day. Write for the illustrated booklet "Products and Processes" which tells how science and industry use Union Carbide's Alloys, Chemicals, Carbons, Gases, and Plastics in creating things for you. Write for free booklet C.*

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ACHESON Electrodes • PRESTONE and TREK Anti-Freezes • ELECTROMET Alloys and Metals • HAYNES STELLITE Alloys

***When the country's largest railroad loudspeaker system*** was planned in the Baltimore and Ohio's yards near Chicago, the choice of cable to be used was a key factor. With 37 miles of underground cable involved, subsequent maintenance costs could conceivably be a major item if any but the best cable were to be used.

Okonite cable was chosen for this job because of its superior rubber insulation and the resistance of its Okoprene sheath to alkalis, acids, oils and other corrosive substances encountered in railroad yard installations. Today, 197 two-way loudspeakers, 50 paging speakers, a complete telephone and printing telegraph system, and an independent inter-communicating system between offices in the yard are operated over Okonite cables in this network.

• • •

Tough jobs are the true test of electrical cable . . . and installations on such jobs usually turn out to be Okonite.

OKONITE *insulated wires and cables*

8783

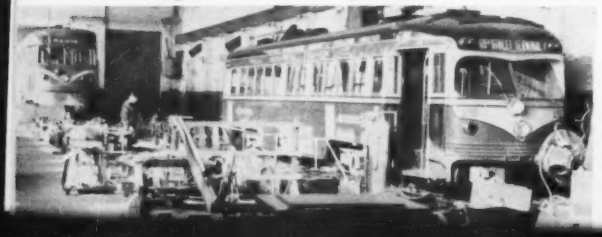
## red arrow

(*Continued from page 18*)

tinues to the very latest housing developments, making Red Arrow as much a part of the residents lives as their own homes.

The excellence of Red Arrow management today is obvious from a look at any recent annual report. In the last year, for example, operating economies resulting in a saving of over $85,000 in conducting transportation were made, despite increased cost of materials and without reducing services. In contrast to so many unprofitable transit systems, often government owned and a drain on the taxpayers, Red Arrow consistently makes a profit, last year paying $124,750 as cash dividends on preferred and common stock. After the purchase, in 1947, of a controlling interest in the Philadelphia and Western Railroad, Red Arrow management turned the deficit operation into a profitable one. This was also due to better coordination of the two lines, resulting in better service for increased patronage.

Service beyond Larchmont, the end of the commuting zone on the long West Chester line is half-hourly during non-rush hours; but service on all other rail divisions is every fifteen minutes. Service on most bus lines is likewise half-hourly and every fifteen minutes; great numbers of extra vehicles, both trolley, bus, and P. & W. rapid transit cars, are operated during rush hours. There is no waiting for vehicles at rainy, windswept street corners for passengers on any Red Arrow line, as schedules are published and strictly adhered to. The management realized that a customer's certainty of getting aboard a vehicle as soon as he gets to the car or bus stop, may make the difference between that customer driving or riding Red Arrow.



Beyond Larchmont the track is single, but the cars pass swiftly on well-planned passing sidings. It is here, as well as on the Media line, both of which are protected by signals, that the streamlined cars hit their stride. The country is less built up, stops become fewer, allowing the cars to run a mile a minute down the single track on the side of the turnpike. As night falls the bright headlight illuminates the track ahead, lighting first the trees on one side, then the road on the other, as the car slows through a series of reverse curves. The operator dims the light for oncoming autos and when a stop is made at a road crossing to pick up passengers. More and more stops are made as the car nears West Chester, then the single track curves into the middle of the town's main street; the car runs slowly down the length of it to center of town.

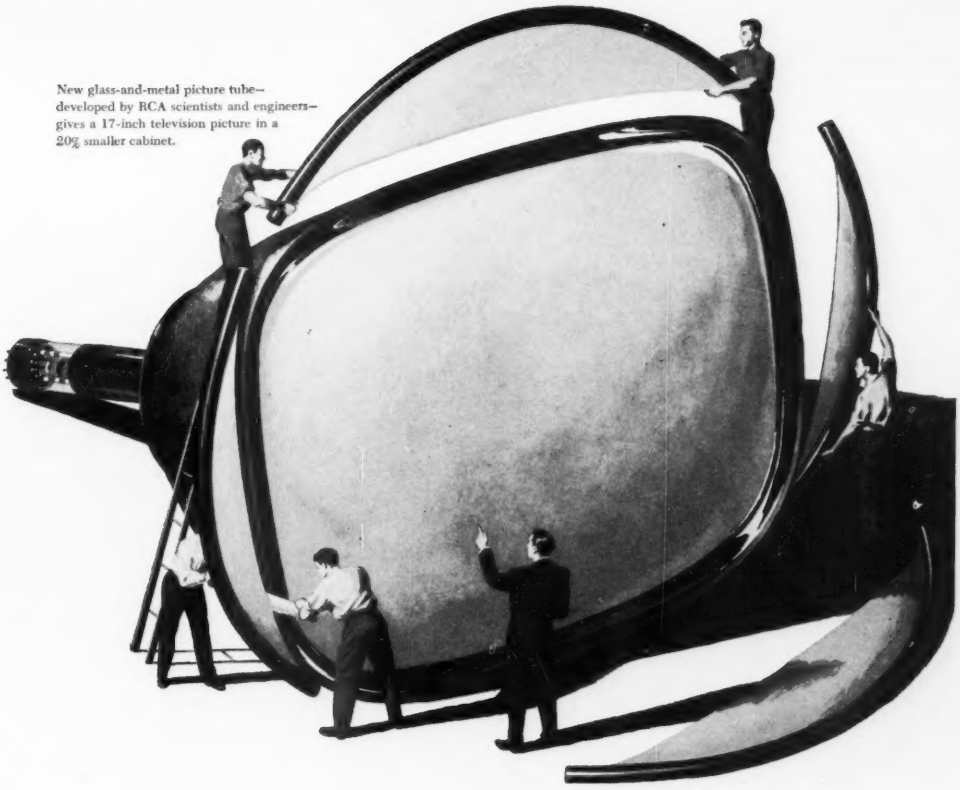
The residents of the area served by the Red Arrow have an appreciation for its services unmatched, perhaps, in the transit industry. They'll tell you of its low fares and fast, courteous service. Their loyalty to the transit lines they ride was demonstrated recently when the State Highway Commission proposed that the West Chester car line be abandoned to make room for a new highway. It is ironic that the growth of population responsible for this suggestion was largely due to Red Arrow's car line being there in the first place. After the Company was reported cool to the idea of replacing these cars with buses, several communities along the line let it be known that they would oppose any suggestion to abandon the car line. The State has since drawn up new plans, for widening the West Chester pike, including the car line on a center reservation. The highway widening may yet prove a disguised blessing to Red Arrow because of the further increase in population it may bring to the area served by this line. People who may settle off the turnpike because of the availability of the highway may, like other suburban car owners, find it more expedient, convenient, and actually less expensive, to ride to work each day via the Red Arrow and the Elevated, rather than drive their own automobiles. This has been the pattern in other areas served by these car and bus lines, where road improvement followed land improvement which followed transit improvement; it may be true here. In any case, the trim red cars will continue to breeze past motor traffic along the West Chester Pike for a long time to come.

## yardstick

A new kind of "yardstick," which uses different colors to measure millionth-of-an-inch thicknesses, was described at the 119th national meeting of the American Chemical Society by Dr. Katharine B. Blodgett of the General Electric Research Laboratory. The device, called a "stepgage," is used to measure thicknesses of materials occurring in the form of extremely thin films.

The stepgage is used like a yardstick, but in place of linear inches are blocks of different colors, each of which represents a different thickness. In films a few millionths of an inch thick, colors vary with changes in thickness, permitting a particular color to indicate a particular thickness.

In using the stepgage, the color of a film is matched to that block of color on the gage. A thickness reading is marked underneath that particular color.



New glass-and-metal picture tube—developed by RCA scientists and engineers—gives a 17-inch television picture in a 20% smaller cabinet.

# *Now—television "squares away" with a* **Bigger Picture**—*smaller tube!*

Ideal for mass production, compact, and lower in cost, RCA's glass-and-metal picture tube was a major advance in television history.

Now comes still another important RCA engineering advance, *rectangular* glass-and-metal kinescopes. Engineered for the big 17-inch pictures you want in a receiver that takes up *less* cabinet space—as much as 20% less—the new kinescope gives you finer pictures than ever before . . . in sharp and brilliant focus over every inch of your screen. And, as yet another step ahead, RCA's new picture tube offers an improved type of Filterglass faceplate—frosted Filterglass—developed on principles first investigated by scientists of RCA Laboratories, to cut reflection, and give you sharper picture contrast.

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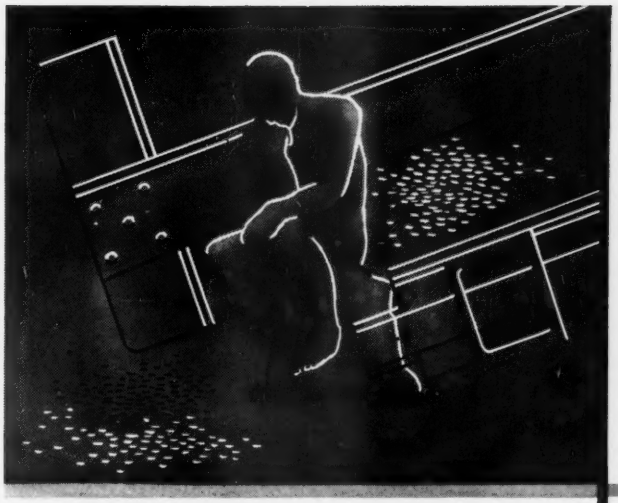

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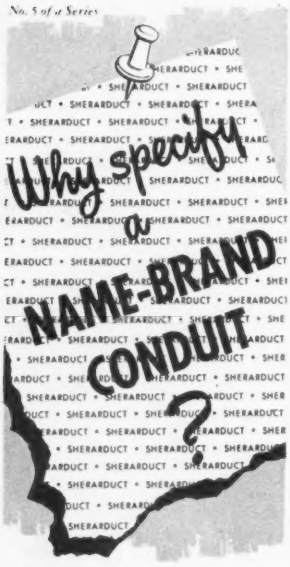


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## faith in science

(*Continued from page 10*)

public, our lawmakers, our molders of public opinion, novelists, columnists, labor leaders, and administrators, have not devoted themselves more to understanding this force which is shaping our present and our future. Wise decisions in which science is involved cannot be reached merely by consulting experts. The very aims and ideals which condition these decisions come from the intellectual and spiritual background of the people who are in positions of responsibility. These ideals come from within and are a part of the culture of the nation. We do not ask an expert to tell us what should be our heart's desire. We only ask him how it is to be attained.

Barring war or other catastrophe our standard of living, and therefore our dependence on science, will increase rather than decrease. Even if our population were decentralized, our dependence on science would not be lessened, but rather increased, if we wish to maintain and better our standards of health and comfort. Is it not folly to believe that a complex organism like our society, dependent as it is on science for its lifeblood and development, can continue to be managed properly by people whose education is not imbued with the living tradition of science, who have never experienced the influence of a scientific discipline?

For what science has to offer, and for what the country needs, a mere interest in the so-called scientific method, without specific knowledge of some part of some science, is as devoid of content as moral principle without moral action.

2

Over and above our lives as citizens, we also live our lives as individuals. What has science to offer as a guide to conduct and to the enrichment of one's inner life?

Fundamental to the existence of science is a body of established facts which come either from observation of nature in the raw, so to speak, or from experiment. Without facts we have no science. Facts are to the scientist what words are to the poet. The scientist has a love of facts, even isolated facts, similar to the poet's love of words. But a collection of facts is not science any more than a dictionary is poetry. Around his facts the scientist weaves a logical pattern or theory which gives the facts meaning, order, and significance. For example, no one can look at a brilliant night sky without emotion, but the realization that the earth and planets move in great orbits according to simple laws gives proportion and significance to this experience.

Theory may be qualitative and descriptive like Darwin's theory of the origin of species, or quantitative, exact, and mathematical in form like Newton's theory of the motions of planets. In both cases the theory goes far beyond the facts because it has unforeseen consequences which can be applied to new facts or be tested by experiment.

A scientific theory is not a discovery of a law of nature in the sense of a discovery of a mind or the end result of a treasure hunt or a statute that has been hidden in an obscure volume. It is a free creation of the human mind. It becomes a guide to new discovery and a way of looking at the world — which gives it meaning.

A successful theory goes far beyond the facts which it was made to fit. Newton in his laws of motion and theory of universal gravitation essentially created a universe which seemed to have the same properties as the existing universe. But it is hardly to be expected that the creation of a finite human mind would duplicate existing nature in every respect. The history of science indicates that it can't be done. Newton's theory has given place to Einstein's theory of relativity and gravitation. The Darwinian theory has been greatly modified by the geneticists.

The great scientific theories enable us to project our knowledge to enormous distances in time and space. They enable us to penetrate below the surface to the interior of the atom, or to the operation of our bodies and our minds. They are tremendously strong and beautiful structures, the fruit of the labors of many generations. Yet they are man-made and contingent. New discoveries and insights may modify them or even overthrow them entirely. However, what was good in them is never lost, but is taken over in the new theory in a different context. In this respect the scientist is the most conservative of men.

More than anything else, science requires for its progress opportunity for free, untrammeled, creative activity. The scientist must follow his

(*Continued on page 26*)

A brief thoughtful glance around any room reveals a startling, seldom realized fact. Practically every object you see has one common characteristic. Abrasives were used in at least one or more stages of their production... almost without exception. Your clothes, furniture, automobile—yes, almost anything you can name is made to closer tolerances... or in mass quantities... or with a better finish because of the part abrasives play in their making.

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## faith in science

(*Continued from page 24*)

thought and his data wherever they may lead. A new and fundamental scientific idea is always strange and uncomfortable to established doctrine and must have complete freedom in its development; otherwise it may be strangled at birth. Ever since the time of Galileo the progress of science has continued without a break and at an accelerated rate in spite of war, revolution, and persecution. However, this progress has not always been in the same country. When science faltered in Italy, it began to bloom in England and Holland, then in Germany. Now that scientific progress is unfortunately slowing down in Europe, science in the United States after an incredibly long period of quiescence has burst out with tremendous vigor.

The great contributions to science in any country have usually come during or close to a period of great vigor in other fields, in periods of optimism, expansion, and revolutionary creative activity. In England it was right after the Elizabethan period. Newton's great contributions came within fifty years after the death of Shakespeare. The other great period in British science was between the Napoleonic Wars and the first World War. It was also a period of great poetry. In the United States the giant figure of Benjamin Franklin had no equal down to the most recent times; his period also produced the greatest statesmen in our history.

I do not wish to imply any necessary causal connection between important achievement in different fields of activity, but no one will deny that certain intellectual, moral, and spiritual climates are more conducive to creative activity than others. No one can deny that the continuity of a living tradition can be broken by the murder, exile, or ostracism of its chief exponents, or that a culture which is sterile can be kept so indefinitely by rigorous police action which prevents the intrusion of alien ideas. We have seen all too many examples of the self-preservation of sterility in recent years.

Fortunately for the scientific tradition it carries with it many gifts some of which are more practical than spiritual, and therefore it has never lacked a new home when the time came to move. Science has never become localized in any place or in any culture. It is merely human and universal. French science and German science, Russian, English, Japanese, and American, do not exist separately as does poetry or some other arts such as law and government. They all speak the same universal language of science and say the same things when they have something to say. When another mode is imposed from without, science either quietly dies or goes away, leaving the field to the charlatan and pseudoscientist.

What then are our conclusions? What does the tradition of science teach us?

It teaches us moderation and tolerance of ideas, not because of lack of faith in one's own belief, but because every view is subject to change and every truth we know is only partial. The strange thought or custom may still be valid.

It teaches cooperation not only among people of the same kind, but also of the most diverse origins and cultures. Science is the most successful cooperative effort in the history of mankind.

Science inspires us with a feeling of hopefulness and of infinite possibility. The road ahead may be invisible but the tradition of science has shown that the human spirit applied in the tradition of science will find a way toward the objective. Science shows that it is possible to foresee and to plan and that we can take the future into our own hands if we rid ourselves of prejudice and superstition.

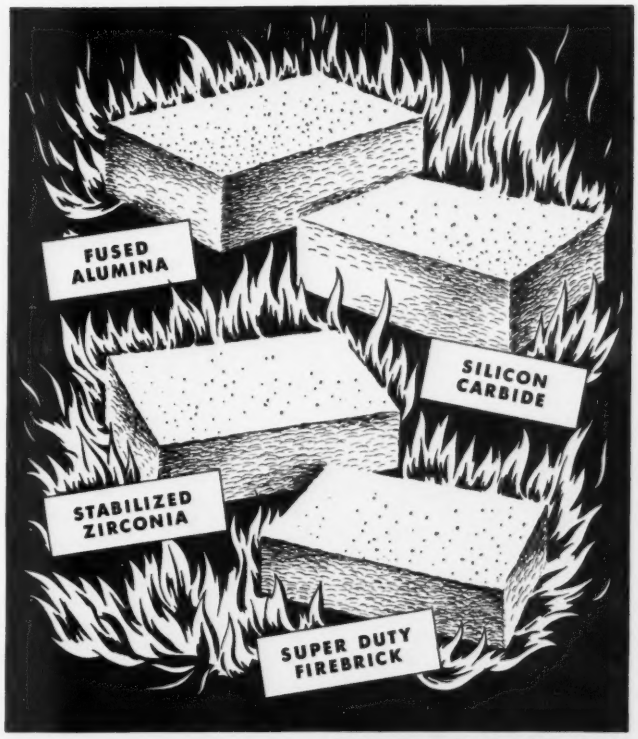
The tradition of science teaches us that no vested interests in institutions or systems of thought should escape continual re-examination merely because they have existed and have been successful. On the other hand it also teaches us to conserve what is operative and useful.

Science teaches us self-discipline. One must continually look for the mote in one's own eye. The history of science shows that it is always there.

These lessons can be multiplied to cover almost the entire range of human activity, because science is itself a contemporaneous living thing made by men for man's edification and entertainment.

I will close with one last point. Science is fun even for the amateur. Every scientist is himself an amateur in another field of science which is not his specialty, but the spirit is the same. Science is a game that is inspiring and refreshing. The playing field is the universe itself.

## *Which of these* Refractories *withstands the* Highest *temperature?*

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No other refractory offers such an unusual combination of properties. Norton Stabilized Zirconia has a *surprisingly low thermal conductivity.* In spite of the fact that its specific gravity is twice that of fire clay brick, its thermal conductivity is only 6 (English Units) as compared with fire clay's 12, fused alumina's 20± and silicon carbide's 50+.

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Equally valuable to processing industries is the *chemical stability* of Norton Stabilized Zirconia, manifested in its ability to resist both oxidizing and reducing atmospheres at high temperatures and its chemical inertness in contact with titanates.

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First to produce Fused Stabilized Zirconia in commercially significant quantities, Norton keeps on "making better products to make other products better" through constant work on new developments. To do this requires new ideas and fresh approaches in the field of research . . . a hint to young engineers and chemists. When you think of your future, think of Norton.

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describes the amazing properties of Norton Fused Stabilized Zirconia in full detail. Write for a free copy.

Neil Ault, Ph.D., Ohio State '50, measures the resistance to deformation of Crystolon* (SiC) refractories at high temperatures in multiple load test furnace.

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Known strength factors! Proved resistance to corrosion! These are your only safe and sure guides to long life and low maintenance expense of water, gas and sewer mains laid under costly modern pavements. The four strength factors that pipe must have to survive traffic shocks, heavy external loads, beam stresses and severe working pressures are listed in the box opposite. *No pipe that is deficient in any of these strength factors should ever be laid in paved streets of cities, towns and villages.* Cast iron water and gas mains, laid over a century ago, are serving in the streets of 30 or more cities in North America. These attested service records prove that cast iron pipe not only assures you of effective resistance to corrosion but all the strength factors of long life and economy, as well.

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*by* O. V. TALLY, *Manager, Midwest Region,*
*General Machinery Division,* ALLIS-CHALMERS MANUFACTURING COMPANY
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O. V. TALLY

YOUR FIRST JOB is the most important job in the world. Picking that first job carefully can mean the difference between a running start in a really satisfying life work and merely working for a living. You must have been giving this problem a lot of thought as you look toward the end of your scholastic career. I had exactly the same problem while I was working for my E. E. at North Carolina State in 1925.

I happen to think that the man who applies his company's product in the field is the most important man in the American business system. Not only does he help create the demand that keeps our factories working, he is also the force behind many of the great improvements in products and processes which have been made. He must know and understand the customer's problems and the factory's facilities, then bring the two together to produce better goods at lower cost.

I knew I wanted this kind of work. Most of all, I wanted to be free to try several fields of work; to find out where my talents lay; to see where my individual effort would bring the greatest satisfaction.

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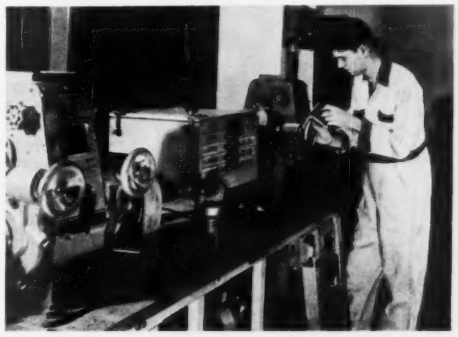
I chose the Allis-Chalmers Graduate Training Course because Allis-Chalmers has a hand in solving the problems of every basic industry . . . food, steel, mining, aluminum, electric utilities, public works, chemicals, and many others. Here I saw my chance to find out which I wanted to work in.

Taking the course in many different departments, I learned as much as I could about as many products and industries as I could. Then I began application engineering in the New York District Office. Since then, I have been in Washington, Philadelphia, St. Louis and Chicago. As it turned out, I didn't specialize in any industry, but worked on applications for all kinds of goods to many industries. And I found the work that has made me happy.

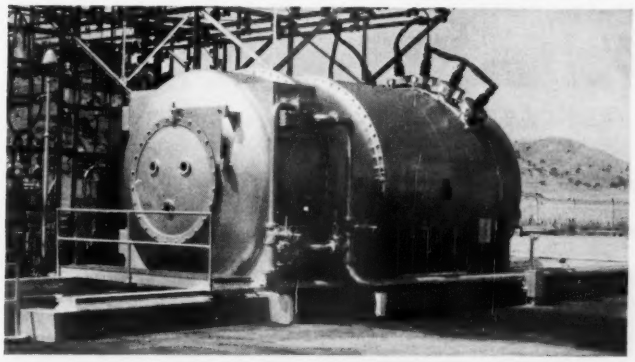
### Find Your Spot

Of course, not everyone wants to be a field application engineer. The Allis-Chalmers Graduate Training Course offers you an opportunity to find out which branch of industry you will be happiest in and which job in that industry you can do best. You choose your own courses and may alter them whenever you like. You choose among electric power generation, distribution and utilization equipment; motors, pumps, blowers; basic industry equipment for processing cement and rock products, ores, wood, chemicals, food; and many other types of equipment. You can get actual practice in design, manufacturing, sales, research, administration, service and erection before choosing which one to follow. And many Allis-Chalmers customers have openings for training course graduates.

As I've said, I believe the most important job in the world to you is your job after graduation. Choose the job that gives you the greatest opportunity for advancement through your own effort. If you want to talk to someone about the opportunities at Allis-Chalmers, visit your nearest Allis-Chalmers Sales Office. Or write Allis-Chalmers, Milwaukee 1, Wisconsin, for details.



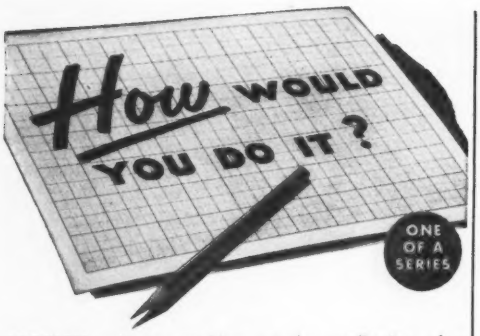
**In Basic Industries** laboratory scaled-down equipment is used to investigate processes and make pilot runs. Lab includes complete food, ore, wood, rock products pilot plants.



**Large Allis-Chalmers** synchronous condenser corrects power factor on giant Southern California Edison Company distribution system.

**ALLIS-CHALMERS**

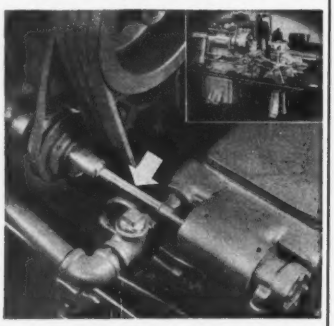
*Allis-Chalmers Manufacturing Company, Milwaukee 1, Wisconsin*




**PROBLEM** — You're working out the application of a hydraulic speed selector system to a turret lathe. The system's oil pump is to be driven by a belt take-off from the main belt drive. Your problem now is to provide a means for transmitting power from the pump drive pulley to the pump that will permit the adjustment of the pulley to regulate belt tension. How would you do it?

**THE SIMPLE ANSWER** — Use an S.S.White flexible shaft between the pulley shaft and the pump shaft. As you see below, that's how the Gisholt Machine Co., did it. An S.S.White flexible shaft is the logical answer for a wide range of drives where one or both of the connected members must be adjustable in position.

*Photos courtesy of Gisholt Mach. Co. Madison, Wis.*



**This is just one of hundreds of power drive and remote control problems to which S.S.WHITE FLEXIBLE SHAFTS are the simple answer. That's why engineers will find it helpful to be familiar with the range and scope of these "METAL MUSCLES"* for mechanical bodies.**

**SEND FOR BULLETIN 5008**

It gives basic information and engineering data about flexible shafts and their many uses. We'll gladly send you a free copy on request.

*Trade Mark Reg. U.S. Pat. Off. and elsewhere

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO. — Dept. C, 10 East 40th St. — NEW YORK 16, N. Y.


# life processes of a cold mill

(*Continued from page 13*)

it is subjected to a myriad of finishing processes which put the metal in the specific condition cited by the purchaser.

When a high quality finish is desired on stainless steels, it is sent to the Hamilton grinder. This machine is a continuous wet belt grinder which operates at a rather low speed while improving the metal's surface by ridding it of rolling and annealing marks.

A cold mill also contains a large number of smaller and lighter mills that make light passes giving a gauge accurate to four decimal places, besides improving the surface characteristics of the metal. A mill such as a so-called steckle mill is used for narrow widths of high carbon steel that is to be finished to a high hardness and temper. The rolls used in this mill have a small diameter, but are worth over a thousand dollars for a set because of the extremely valuable alloying agents used in making the rolls.

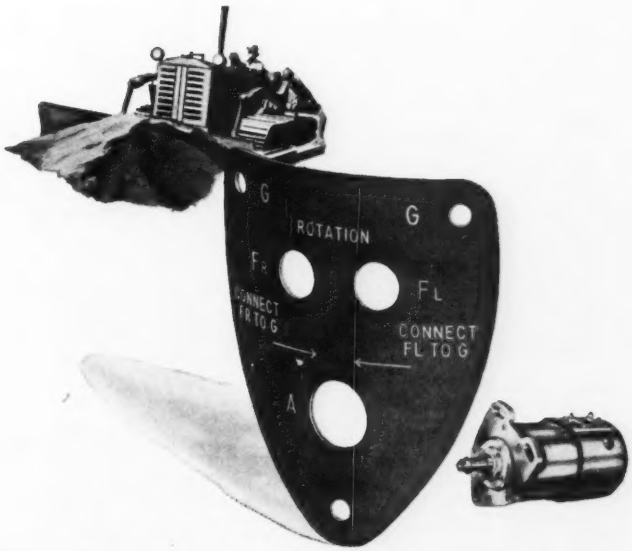
Since manufacturers often demand very narrow widths of steel, it must be slit on machines called shears. Shears cut by means of a series of hardened steel disks separated by spacers of the desired dimensions. Except in rare cases, the steel is sent to the shears in a fully annealed condition. Keeping the six or more narrow strips rolling up evenly at high speeds calls for specialized skills and fast action.

The cutting action of the slitter on the shears produces a sharp curled-over edge on the narrow strips which must be removed on the rewinder. The rewinder consists of a series of files set at different angles, through which the steel is pulled, removing the burr from the underside of the strip. The rewinder is also equipped with a turkshead which is used to emboss designs on the strip.

All the steel that leaves the mill must pass through the shipping room where it is cut, inspected, trimmed, wrapped and boxed for shipment. These operations are mostly semi-manual since the mammoth multi-ton coils have been sheared and cut into convenient sizes. Due to the nature of the handling, these operations are an open field for the time-study engineer, and bonuses are given out for overtonnages put out each week.

Welded steel tubing produced on the tube mill is finding an increasing outlet throughout industry. The tube mill forms narrow coils of steel that have been carefully sheared into a circular shape by means of a series of forming rolls. The seam is then sealed by resistance welding, the burr removed, and the tube cut into sections of desired length. The machine runs at a speed of eighty to one hundred feet per minute, which may amount to 150,000 feet of tubing in a single week.

This has been the story of a small segment of the biggest industry in the United States, a story that in its entirety is so vast and so complex, that it is almost impossible for one to keep up with its tremendous growth. Never let us forget, however, that steel is the backbone of our industrial might, and without the help of that ever advancing group of adventurers, the metallurgists, and their works of art, the steel industry of America, we would be without its tremendous potential that has put us in our present position of prominence.




## *How to move mountains—non-stop*

When it comes to moving mountains—or spreading the landscape around—you can't beat bulldozers.

You can, however, beat a bulldozer if you put into it a part that can't stand the gaff.

An example is the generator. Vibration, abrasive dust, weather, shifting stresses and stray oils or greases are constantly taking their hardest licks at it. It leads a tough life.

That's why American Bosch Corporation, makers of dust-proof, heavy-duty generators for industrial tractors and bulldozers, selected Synthane laminated plastics for the insulation plate shown above.

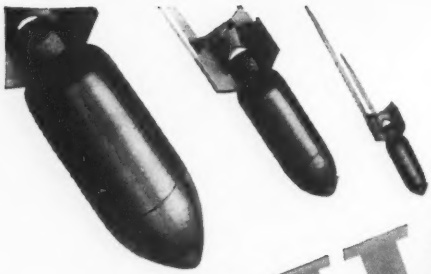
Synthane is a material for industry. It possesses an unusual *combination* of physical, mechanical, chemical and electrical properties.

Synthane is light, strong, dense, abrasion resistant. It is easily machined or produced in formed shapes. Dielectrically strong, it is a natural for electrical applications. Synthane is corrosion and fungus resistant, chemically inert, stable over a considerable temperature range.

If this capsule description of Synthane piques your imagination, send for the complete Synthane catalog. Synthane Corporation, 10 River Road, Oaks, Pennsylvania.

PLASTICS WHERE PLASTICS BELONG

SYNTHANE



# WHICH?

It's difficult to think of a slender match in the same class with a Block Buster, yet both can be equally destructive. When a plant is burned out by a carelessly thrown match, it's just as dead as though it were bombed. Actually, losses may be even greater, for fire is arch-enemy to precious machinery and irreplaceable records. That's why two out of five burned-out businesses never come back . . .

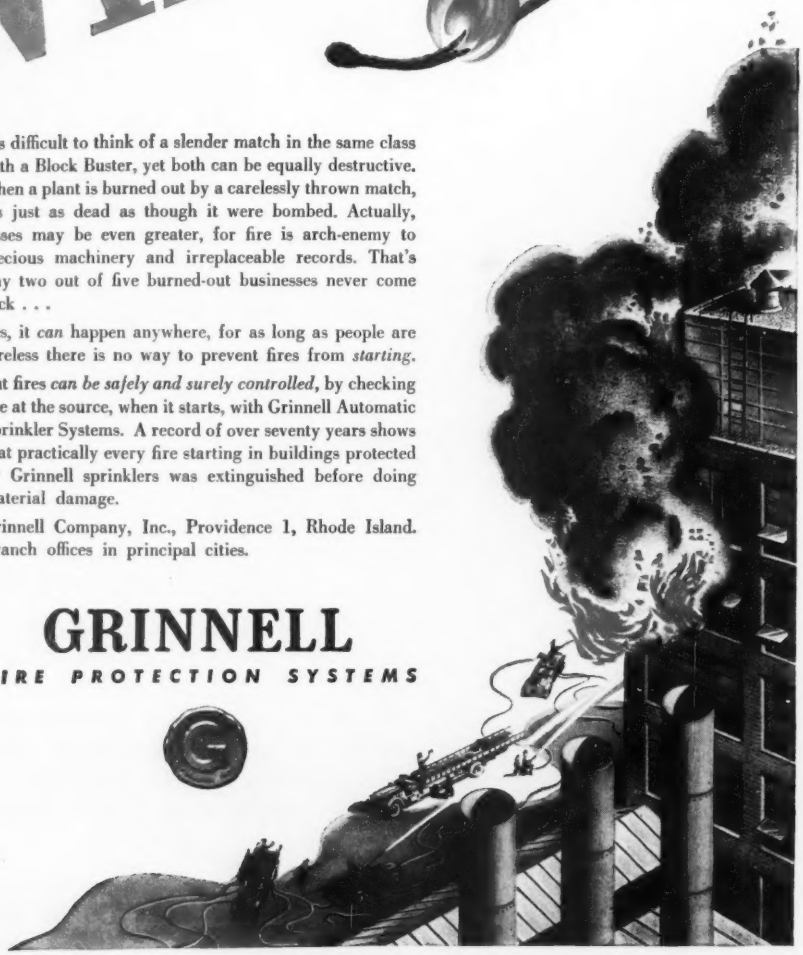
Yes, it *can* happen anywhere, for as long as people are careless there is no way to prevent fires from *starting*.

But fires *can be safely and surely controlled*, by checking fire at the source, when it starts, with Grinnell Automatic Sprinkler Systems. A record of over seventy years shows that practically every fire starting in buildings protected by Grinnell sprinklers was extinguished before doing material damage.

Grinnell Company, Inc., Providence 1, Rhode Island. Branch offices in principal cities.

## GRINNELL

***FIRE PROTECTION SYSTEMS***

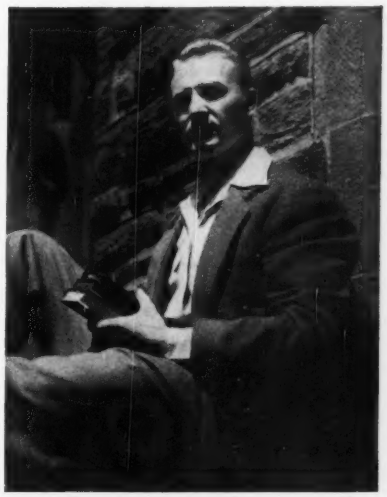


**ENGINEERING GRADUATES HAVE FOUND ATTRACTIVE OPPORTUNITIES WITH GRINNELL**

# YOU REMEMBER LOU . . .

## *He'd Give His Eye Teeth For This Opportunity*

Lou came out of W. W. II with the bug for electronics. He'd been an electronics maintenance specialist in the Navy . . . attended service schools in radar, sonar and gunfire control to earn his petty officer's rating. He came to school under the GI Bill . . . majored in electronics . . . now has his degree in electrical engineering . . . Lou is doing all right now but wishes he could be closer to his chosen career — *electronics.*



***Maybe you know Lou—or somebody like him. Perhaps you yourself have a similar background and can qualify for this unusual opportunity to secure broad foundational experience in the rapidly growing field of electronics engineering.***

## RAYTHEON GOVERNMENT FIELD ENGINEERING

GOVERNMENT FIELD ENGINEERING is our name for the Raytheon organization which supplies world-wide technical service to the Government relative to the intricate electronic equipment which we manufacture. This highly qualified group has won an acknowledged eminence among similar organizations. During World War II, Raytheon produced more search radar for the Navy than all other manufacturers combined. Its Submarine Signal Division has been the leader in sonar and underwater sound since 1901.

Since V-J Day, Raytheon has continued in all phases of electronics development and production for the Army, Navy and Air Force, and is now being called upon to gear its facilities to the growing needs of the Armed Forces. We now have a limited number of openings for candidates who have the special service and educational background required and who can meet the rigorous qualifications which we must impose in order to maintain our high operating standards.

### JUNIOR FIELD ENGINEER

Successful applicants for the position of Junior Field Engineer in the Raytheon Government Field Engineering Organization will have the same general biography as our friend, "Lou". Military experience with electronic equipment in the Army, Navy or Air Force is desirable. A degree from a school of Physics or Electrical Engineering in a recognized college or university is essential. Experience after graduation is of little consequence.

The position of *Junior Field Engineer* presents a rare and unusual opportunity to become acquainted with the most modern techniques in the science of electronics. For the graduate engineer, it is a once-in-a-lifetime chance to familiarize himself with the many phases of electronics prior to specialization.

Junior Field Engineers are called upon to (1) supervise equipment installation, (2) supervise or personally attend to its repair and maintenance, (3) train military or other qualified personnel to operate, repair or maintain it, and (4) contribute toward the solution of engineering problems which may arise in the field. The Junior Field Engineer may be called upon to undertake important missions of a classified nature in the interests of the Government. He will at all times, by the nature of his position, be a representative of the Raytheon Manufacturing Company responsible for sustaining and improving our relationship with and service to the Government.

SALARY AND BENEFITS are liberal, commensurate with the technical knowledge and skill and the responsibility involved. They include travel and subsistence payments, free accident insurance, low cost life insurance, retirement and hospitalization plans. All in all, this adds up to a job for which only a relatively small group of engineers can qualify, but in which successful applicants can profit more professionally and financially, can advance more rapidly, and can acquire a wider range of valuable and interesting experience than in any other branch of the industry.

### WHO CAN QUALIFY?

Practicing engineers, recent graduates and those about to graduate are eligible to apply; preferably those between the ages of 22 and 30. If you know of a qualified applicant, you will be doing him a tremendous favor by calling this opportunity to his attention. All applications will be carefully considered and held strickly confidential. Send a brief resume to

*Government Field Engineering*

**RAYTHEON MANUFACTURING COMPANY**

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RAYTHEON

*Excellence in Electronics*

# briefing the news

## Portable Television Camera . . .

A new portable television camera and transmitting station, designed to operate in the field as a one-man back-pack unit, has been developed by RCA engineers.

Weighing only 53 pounds, the back-pack station is planned to function with its own battery-power supply. It has a range of approximately one mile. Because of its easy portability, numerous applications for the new equipment are foreseen by research engineers. Among these are news coverage, with television-equipped reporters flashing pictures and commentary directly to editorial rooms, and remote industrial viewing and control.

The new transmitter operates in conjunction with a control station which may be located as far as a mile from the camera. Signals corresponding to the scene being televised are transmitted to the control point on an ultra-high frequency with a power of two watts.

**With a range of one mile this new TV camera offers possibilities for improved television news coverage.**

In addition to acting as a monitor for the televised picture, the control point performs two other functions. It sends out a stream of pulses which stabilize the camera and can be used also to issue vocal instructions to the cameraman.

Recent developments in the design of pencil-sized tubes and other sub-miniature component parts made possible the impressive reduction in bulk and weight of the equipment.

The back-pack is carried in knapsack fashion, suspended from the narrator's shoulders by flexible straps. Two small antennas extend from the top of the pack and are used respectively to transmit the picture signal to a base station and to receive voice and control signals from that same point.

The camera is an adaptation of the RCA industrial TV camera using the Vidicon tube. As an added feature, the camera includes a miniature kinescope picture tube which serves as a view-finder for the cameraman. Through it he is able to see an exact reproduction of the scene on which the camera lens is focused.

The equipment contains 42 tubes which, with their associated circuits, provide all synchronizing frequencies for a standard 525-line, 30-frame interlaced television picture. Included in the unit are the battery-operated power supply, deflecting circuits, amplifiers, and a radio receiver for receiving instruction and other essential information from the control point. A single battery operates the portable station for about 1½ hours.

The narrator-cameraman's voice is picked up and transmitted through the combination of a small microphone built into the camera case and an ingenious electronic circuit which adds the voice signals to the picture signals as they are radiated to the control point.

## Digestible Sawdust? . . .

Experiments conducted in the General Electric Research Laboratory, in collaboration with the department of bacteriology at the State College of Washington, show that irradiation with high-voltage electrons, or cathode rays, makes part of the sawdust digestible by organisms in the cow's stomach. A cow is able to utilize pure cellulose (such as cotton) as food. Wood consists largely of cellulose, combined with another compound, called lignin, in which combination it is indigestible. The cathode rays make the cellulose available. Bacterial action in the rumen, the first of the cow's four stomachs, is able to convert the cellulose into several other compounds, such as acetic, propionic and butyric acids. These are generally known as the volatile acids, and can be absorbed in the animal's intestines.

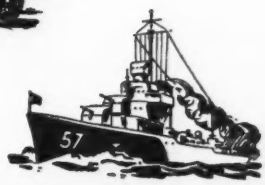
After irradiation, the basswood samples were sent to the bacteriology department at the State College of Washington. Since the tests could not be made with enough precision on live cows, the work was done in test tubes, using cultures of bacteria from a cow's rumen. Tubes containing the irradiated sawdust and the bacteria were kept from one to two days at a temperature of about 100° F. This is the cow's body temperature a little higher than that of a human.

Following the test tube digestion, steam was bubbled through the samples, causing the volatile acids to be evaporated. The vapors were then condensed back to liquid which was added to a caustic soda solution of known strength. By determining how far the volatile acids neutralized the caustic, their amount could be measured.

At the intensity of radiation employed, exposures of less than a minute produced no great effect. The maximum was obtained with an exposure of about 12 minutes. Then the digestibility of the bacteria was about the same as for hay.

Sawdust has been used in Europe for cattle fodder by giving it a sulfuric acid treatment, which breaks down the lignin and makes the cellulose available for digestion in the rumen.

**FASTER**



**FASTER**

**FASTER!**

## AUTOMATIC GUN-LAYING

Some things man just can't do fast enough — manually. Time was when gun-pointing information was transmitted to dials and guns were pointed manually in accordance with the data.

Arma was in the thick of the apparatus development which brought gun fire control to this point. And, it was Arma who undertook to aim the guns automatically.

All that was *before* jet planes were a reality—*before* supersonic planes introduced such terms as "Mach 4" into military language. Adapting and improving the speed of apparatus for the automatic control of anti-aircraft batteries is one of the important assignments of accelerated engineering at Arma. It is typical of many ways Arma engineers are aiding in making America safe against those who wish to destroy it.

*If you think you might like to start your engineering career at Arma, write for the booklet titled "Engineering at Arma." Please address your request to the Engineering Division, 254 36th Street, Brooklyn 32, N.Y.*

**PRINCIPAL PRODUCTS** Gunfire Control Equipment · Remote Control Equipment
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# Massachusetts Institute of Technology

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THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY
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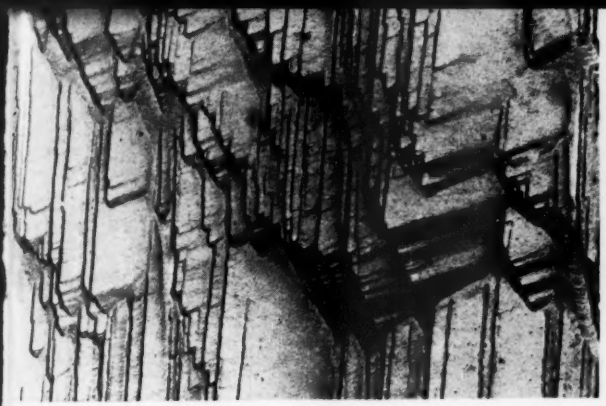
The duration of each of the above undergraduate Courses is four academic years and leads to the Bachelor's degree, with the following exceptions: (1) Architecture and Marine Transportation, which are five-year courses leading to the Bachelor's degree; (2) Food Technology (Five Year Course), Physical Biology, and the Cooperative Courses in Electrical Engineering and in Mechanical Engineering, which extend over a period of five years and lead to the Bachelor's degree and the Master's degree.

Graduate study may be pursued in Textile Technology, Ceramics, Sanitary Engineering, and in most of the above professional Courses. The Master's and Doctor's degrees are offered in most of these fields.

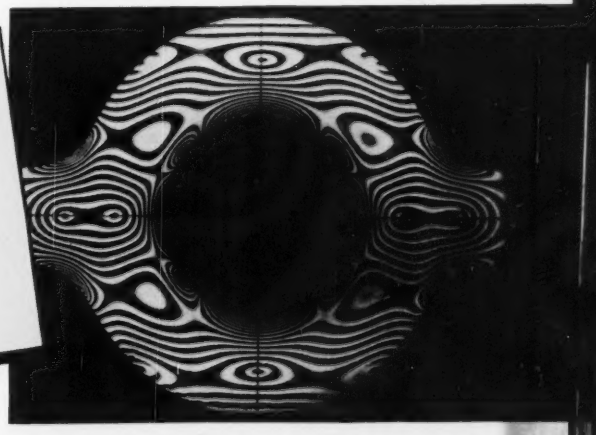
For information about admission, communicate with the Director of Admissions. The Catalogue for the academic year will be sent free on request.



**REVEALS NEW FACTS ABOUT METAL STRUCTURE.** Electron micrography—up to X50,000 with the electron microscope—reveals new facts about metal structure, surface protection, and effect of processing procedures.

**DETERMINES COMPOSITION OF MATERIALS.** The composition of almost any material is shown in a flash through spectrography. It is a means of making frequent production line analyses that keep a check on specifications.

# Engineering has an ally in photographic analysis



**SHOWS STRESSES AND STRAINS VISUALLY.** By photographing the patterns developed by polarized light as it passes through a plastic model of a part, the engineer can have visible evidence of the points of stress within the part.

In the engineering laboratory—on the production line—photography is today an important tool. It searches metal structure through electron micrography, x-ray diffraction, and micro-radiography. It makes swift mechanical motions seeable by showing them at a snail's pace with high speed movies. Or it can halt an instant of an instrument's fleeting trace and record it for study.

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ON "TEST"—that's the popular name for the Student Engineering Program, by which most engineers enter the company.

# Four broad avenues by which college graduates begin careers with General Electric . . .

Both the individual and the company learn a lot when a college graduate enrolls in one of these four basic General Electric training programs.

The individual familiarizes himself with the company's products, organization, and problems. By rotating through a series of varied job assignments he determines the kind of work that most appeals to him and to which he feels he can make the greatest contribution. Many students go on from these courses to more specialized training in advanced engineering, sales, manufacturing, etc.

On its part the company learns about the individual's abilities and capacities. The training programs are a major means of recognizing young people of talent and creative ability, of making sure that they move ahead to new and constantly more challenging assignments.

A very large percentage of General Electric's top scientists, specialists and managers of today began their careers as student-workers in company-conducted training programs.

*You can put your confidence in—*

**GENERAL ELECTRIC**